

My First Colo

A guide for implementing your first wholesale colocation
presence

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<https://github.com/cpc2018/my-first-colo>

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Audience:

This is intended to be a guide primarily for datacenter, network and systems folks installing at their first large colocation facility. It also provides a lot of resources for other team members.

The size of the colocation facility referenced for this document should be somewhere from 50-200 racks, at up to 16Kw per rack (a 500kw – 2Mw deployment). It can scale beyond 200, and below 50, but adjustments will be needed.

The latest version of this file (and other reference documents) can be found here: <https://github.com/cpc2018/my-first-colo>

Purpose of the document

I wrote this document to help provide guidance on the initial set up of a colocation presence. It provides suggestions on how to phrase what you are looking for, some background terminology, advice for staffing, some best practices, and advice on keeping your cage organized, clean, and easy to troubleshoot (at least on the physical layer).

With the advent of Cloud Computing, at a certain size (usually when large bills arrive) companies start to look to come out of the cloud and build their own infrastructure. However, it appears that a lot of the best practices I learned when I started, have been lost. This document attempts to put some of the best practices, and background down in writing, and hopefully removes some (not all) of the pitfalls of building your own infrastructure.

Having built colo spaces for the past 20+ years, there are various problems that seem to keep appearing; undersized builds, poor contracts, a misunderstanding of the datacenter terminology, disagreements between teams, on the ground issues of spiderwebs of cable, lack of commonly needed parts on-hand, lack of organization (when you need a cable, it involves digging through a box, (usually when the site is down)), incomplete or incorrect documentation, a good way to expand, and a reliable way to work on infrastructure.

What this covers:

This document provides examples of the steps needed to bring up a cage and common cage related infrastructure. This will enumerate a list of steps, people, and parts needed to find the right datacenter, and after you get it working, to keep it clean, and trouble free.

What this does not cover:

This does not cover specific versions of networking gear to buy. Everyone has a preference, and this document will not tell you which brand of networking vendor to buy. It may mention networking gear, for specific use cases, (eg: how to wire for them), but this document is not intended to prefer one hardware manufacturer over another.

The document also has a general assumption you know what types of servers you need, (eg application, DB, web etc.).

This is also not a comprehensive list and does not dive as deeply as possible into all of the sections needed. (There had to be some limit to how long this document was).

Knowing what you don't know

One of the hardest parts of setting up your own space, is finding out all the different steps and things that you need to do, so that you can have a working location.

The type of Colo you need.

Personnel needed.

Putting your requirements together

Costs, 3,5,10 year projections

Site selection. (RFP/LOIs/Contracts)

Documentation! (Floorplans, copies of contracts,)

Racks/Cabinets

Servers

Switches

Routers

Misc. Rack parts (eg: patch panels, fiber cables, power strips etc.)

Crossconnects

Contracts for Space, Power and cooling. Details on growth plans (ROFR/ROFO etc.).

Contracts for network providers, backhaul, dark fiber etc.

Sundries (Spare parts (eg: fiber cables, tools etc.))

Cutover plans,

Does this align better with costs?

Types of Colos

There are varying different types of colos. For this document, you will probably be in either a premiere colo, which is network and connectivity dense, or a wholesale colo, which should be cheaper, but with less provider choices, but lots of room to expand.

The wholesale colo (this is the target for this paper)

- The contract will be very much like a real estate contract, and will probably have a longer lease time (5 - 7 years) vs a shorter contract that you would see in a smaller build. The contract will be significantly longer than a smaller colo presence. You may want to contract a real estate broker that deals in datacenter space to help with the process. This is usually a modified gross or triple net lease. There will probably be multiple extension options, of ~5 years each, (taking the contract up to ~15 years).
- The location will probably be found by a detailed RFP process.
- Power should be at a metered rate.
- PUE is broken out.
- Crossconnects should be free, but may have a 1 time NRC.
- There will be a handful of carriers in the building
- There may be a peering fabric.
- Security, access, and remote hands should be available 24x7
- There should be dedicated storage and office space available for you. Depending upon the size of your install, you will want between 1000 - 2500 sq ft for your office / storage.
- You will have a lot more influence on the electrical buildout, cable distribution layout etc.
- A very close look at things like floor loading, and overall building design is needed.

The high wholesale colo

This is a provider of large spaces (usually from 250Kw up to rooms of ~2Mw).

- The contract will be very much like a real estate contract and will probably have a longer lease time (3 - 7 years) vs a shorter contract that you would see in a smaller build. The contract will be significantly longer than a smaller colo presence. This is usually a modified gross or triple net lease.
- The location will probably be found by a detailed RFP process.
- Power should be at a metered rate.
- PUE is broken out.
- Crossconnects should be free, but, may have a high NRC or a monthly MRC.
- There will be a handful of carriers in the building
- There may be a peering fabric.

- Security, access, and remote hands should be available 24x7
- There should be dedicated storage and office space available for you. Depending upon the size of your install, you will want between 1000 – 2500 sq ft for your office / storage.
- You might have a lot more influence on the electrical buildout, cable distribution layout etc. but the DC may not be that flexible.
- A very close look at things like floor loading, and overall building design is needed.

The premier (high retail) colo

This is a colocation provider that can provide you space, but may be more costly. Things you will generally see:

- Designed for a 0-250Kw footprint
- Contract will be for 2-3 years.
- Power will be at allocated rate (not metered)
- Crossconnects will have a monthly cost.
- A peering fabric option.
- Multiple high speed (10gig +) providers installed in the facility, offering transit, metro and long haul services.
- There will generally be a remote hands option
- Full time security, full time access, and the ability to receive packages around the clock.

This is generally a good choice,

- if you have a lot of traffic that you want to egress out of a small footprint (as opposed to hauling it around).
 - If you have limited headcount, and plan to rely on their remote hands.
 - If you need peering, or well established procedures.
- TIP: If you actually pull your power circuit to within the planned threshold (usually 80%, then your numbers will start to pencil out). But, the less efficient you are, the harder it is to make up the difference.

The standard colo

This is a colocation provider that will provide you space and power, but you may have other issues. Things you will generally see:

- Designed for a 0-250Kw footprint
- Power may be at an allocated or metered rate (metered is preferred).
- Crossconnects may be free, a one-time NRC, or a reduced monthly rate.
- There may not be a peering fabric, or if there is, it is an independent one.
- There may not be multiple carriers, in fact, it may just be the colo provider offering their own transit. (This is usually significantly more expensive than market rate). A good standard colo will have a decent amount of carriers, and relationships, to get more carriers in.

- You may have issues hauling your traffic out of the datacenter, (you might be limited by contract, or there are no providers to offer the service). Pay close attention to the on-net network providers.
- Security and access should still be 24*7, but things like remote hands may not be.

This is generally a good choice:

- If you have a small amount of traffic (eg <5 gig), as you won't need to worry extensively about backhaul (to a well-connected facility) and can pass all of it off at this one location.
- If you are cost conscious about datacenter footprint, and can get all of your bandwidth/crossconnect, and space concerns resolved, (eg: locally, or via fabric provider).
- When you are connecting to other providers that are within the building. A lot of larger networks are expanding out of the high retail facilities, as there is minimal room (and power) for them to expand.

Building a colo from the ground up/Fully occupying a building

- Beyond the scope of this document. But this would involve taking over a full building. This work can be contracted out to one of the various datacenter builders. Maintenance of the mechanical/electrical plant may be done by either the datacenter operator, an outsourced operator, or your own electrical team.
- This may also involve various tax incentives, detailed site selection around fiber paths, electrical cooling, average external temperature, room to grow etc.

Summary of Colo Differences.

	wholesale	high wholesale	standard retail	premier (high retail)
space size	250kw-2Mw	250kw-2Mw	0-250Kw	0-250Kw
# racks	25-200	25-200	0-25	0-25
power billing	Metered	Metered	Metered or allocated	Allocated
sq footage	up to 12k Sq ft	up to 12k Sq ft	up to 750 Sq ft.	up to 750 Sq ft.
contract length	5-7 yrs + renewals	5-7 yrs + renewals	2-3 yrs	2-3 yrs
crossconnect billing	possible NRC / monthly	NRC + high monthly	possible NRC / monthly	NRC + high monthly
Peering fabrics available?	possible	highly likely	possible	definitely
Backhaul needed?	likely	possible	likely	n/a - most on-site
dedicated office	likely	likely	unlikely	unlikely
dedicated storage?	likely	likely	unlikely	unlikely
# Carriers	1 to 5	5 to 20	1 to 5	20+
security 24x7	likely	expected	likely	expected
engineering 24x7	possible	likely	possible	expected
broker needed	recommended	recommended	no	no
lease style	triple net or modified gross	triple net or modified gross	monthly contract	monthly contract
estimate time to go live	120-210 days	120-210 days	60-150 days	60-150 days

Personnel needed:

In building your first colo, you will need a large cast of characters. Some of them will work for your organization, some may be contractors, others will be vendors. Some of these roles can be done by the same person.

- **A Contract Lawyer.** Someone who can look at the contracts, and make sure that the terms you are signing up for, are acceptable to you and your company. This can be a contracted role, and it is suggested to find someone with datacenter and network contract experience. While a multi year build with a datacenter should go well, the contract, and all related paperwork, may be your only recourse as the relationship evolves. Key dealpoints to pay attention to, are renewals, price escalators, termination rights, and SLAs. Detail on these dealpoints to pay attention to are discussed in the “picking a colo” section further on.
- **Executive Sponsor** – Building a Colo, is a large spend, with racks of servers ranging in cost from ~150K USD to ~1MM USD per rack. Racks of networking gear can also have similar costs. Also, rent, power, and cooling can be over \$200K per month, per Megawatt. Due to the size of this amount, most companies will require an executive for this project to roll up to. Make sure they are on board early and keep them up to date with issues. They will also be responsible for securing the budget, as well as budgeting for datacenter expansion etc. As an example, a 50 Rack facility, with 50 \$250K racks, could end up costing \$12.5MM USD for the hardware alone. When adding in rent, power, cooling, connectivity etc. the number will be much larger!
- **Datacenter Broker.** A commercial realtor who is familiar with the datacenter market in the area you are looking for. They should be able to help find viable locations, negotiate a good price, as well as understand if the facility meets your requirements. You may elect to go it alone here as well. (note: if you use a commercial realtor who is not familiar with datacenters, you may end up with a significant issue (ex: do not use the broker who found your office space))
- **A rack integrator.** A rack integrator is a company that can send fully integrated racks to your datacenter. They should have the ability to help you make an informed decision about which racks to use to meet your needs, source your server (and maybe network?) infrastructure, put it all together, test it according to their and your criteria, put it in a crate, and send it to your datacenter. A good integrator can be a huge help; in the time saved on the ground, keeping the project on track, letting you know of potential issues seen in similar customers, or of upcoming hardware/parts shortages, changes and upgrades.
- **Networking Reseller.** Depending upon your choice of networking vendor, not all integrators may be able to sell that hardware. As such you will have to work with a Networking Reseller to procure the hardware and send it to the Rack Integrator for integration. It is “ideal” for this to

- be the integrator if possible, as then they can control the timeline end to end for sending out the racks.
- **Datacenter / Network Architect** – At least one person, (ideally two or more) who knows how everything is supposed to tie together.
 - o How rack to rack communication works. (Cabling and protocol wise)
 - o What each rack/cage can scale to (traffic, footprint, power and cooling wise)
 - o Can understand the costs and tradeoffs that are needed to meet the business needs and deliver a solution.
 - **Finance/Procurement Team** – Able to work with Integrators, Resellers, and Datacenters, to place POs, get hardware ordered on time, and keep the project on track monetarily.
 - **Project Management** – This is a project with parts coming from multiple different sources, timelines from the datacenter, multiple teams at the office (Datacenter Team, Systems, Networking, Development), as well as involvement from the execs, due to the size of the capital spend. Keeping all of the people involved and the project on-track is a tough proposition.
 - **Systems/SRE Team**. – A set of systems folks who can configure all of the server infrastructure that is being installed, ideally from the office, while letting the Network and Datacenter team know of any issues. They will enable you to serve content out to your users. Also, the team needs to be clear on how and what type of servers are needed to make the DC successful.
 - **Network Team** – A set of network engineers who can configure your switches, routers, and turn up circuits with remote peers and remote networks. They should work hand-in-hand with the datacenter and systems team to turn up the colo and confirm the colo is reachable. Able to procure address space, and an ASN.
 - **Security Team** – A focus on security is needed for any edge facing infrastructure. A good understanding of your architecture, and the security tradeoffs as it relates to your own colo, is something that should be done, prior to installing.
 - **Datacenter Team** – To help get everything up and running, co-ordinate with the datacenter etc. you will need an on-site datacenter team for the initial bringup. This then will translate to having to handle the ongoing day to day maintenance (server triage, swapping drives, optic swaps, additional cabling) etc. You should also determine, if this team will be at the datacenter on an 8x5 rotation, up to a 24x7 rotation, as this will affect the staffing needs.
 - **Monitoring / Tools Team** – To build dashboards, and alerting to allow you to monitor the datacenter and the infrastructure.
 - **Capacity Planning**. – The turnaround time to procure parts (servers, routers, cables etc), can now vary from between 1 day to 40 weeks), depending upon a multitude of factors (even worse during the current pandemic). The average time to procure a fully assembled rack, can be

multiple weeks (I usually use 8 weeks as my figure, (using ~16 weeks currently)). Having a good capacity planner, who is aware of ongoing utilization, upcoming hardware needs, product pushes, etc. will ensure that there is always capacity available when needed, and new capacity on the horizon. When hardware is not ordered in time, you can very quickly run out of capacity. If you are moving out of a cloud infrastructure, the long leadtime of actually getting hardware, (as opposed to there always being capacity) is probably the hardest thing to change in a corporate culture.

- **Electrical Company / Electrician.** - With a large build out, you will be working with an electrical contractor. The datacenter should have a list of ~3 different firms that they have worked with and can recommend. This company should have done multiple datacenter buildouts, and can provide examples. They should be very familiar with the permitting process for the local jurisdiction.
- **Low Voltage Cabling company** - Similar to the Electrical Company, you will be using a cabling contractor. They will be the ones setting up the cabling (fiber, copper) infrastructure. Make sure to explain your requirements of wanting to be able to bring racks in, or out, as this will help design a flexible infrastructure. They should be very familiar with the permitting process for the local jurisdiction.

Any combination(s) of [not just] these roles can be a single person. It is possible, to merge roles, but be conscious of the amount of work one person will have to do, and the gaps in knowledge.

Make sure that you have the right staff where you need, that the teams are aware of what is needed from each team, and that they have staff and time to make it successful. Ongoing, make sure you have headcount projections to be successful.

Group Consensus and Group Communication.

As you can see, there are a lot of people involved, a lot of moving parts, and a lot of chances for things to go wrong.

Make sure you have all the team members on the same page. Know what the 1,2, and 3 year plan look like and have everyone agree to it (especially Finance and your Executive Sponsor). Know when you have to expand, server, datacenter, and people wise. Know what you want your redundancy to look like over the years. Hopefully the long-term plan is to be able to lose any datacenter, and keep the website running with no impact, but in the beginning that's a far-off hope.

Budget and plan around a steady delivery cadence.

Make sure that your hardware ordering and delivery plans are forecasted out far in advance, so that finance can plan around it, eg: get debt financing, loans, raise funding etc. if needed. Always try to bring in hardware when you will be able to bring it up at a standard pace. If you are asking for things to be ordered / delivered in an emergency, things will get missed.

Putting your requirements together

Early on, you will need to figure out what you are asking for, and what is your success criteria. At a minimum this is:

How much space do you need

Room for X # of racks, (this is usually derived from understanding how many cores, storage you currently use, and growth projections etc. You will then need to figure out how much space you will want over the lifetime of this contract, assuming that you will be paying for 100% of the space taken down at the end of year 2. You will then translate that into # of racks, which should then derive how much square footage you need. (you will also need square footage for network racks, spares storage, growth etc.)

Note: You don't have to solve for 5 to 15 years of continuous site growth. In well-connected markets, you can open additional facilities, then connect the sites together, (also you may be expanding in other geographies as well). Also, you will be taking advantage of hardware refreshes when possible from depreciation.

How much power?

Y Amount of power. (Derived from figuring out how much power a rack will take, (usually from 5-20 Kw each), and multiplying by how many projected racks.)

Also, make sure to select the right type of plug, that is a balance between your long term needs (so you aren't re-running the plugs every few years).

Here is a list of common US plugs, and the allowable wattage per plug

common US Plugs	Voltage	Amperage	3 PH?	Neutral	100% watt	80% Watt
L5-20	120	20	N	Y	2400	1920
L5-30	120	30	N	Y	3600	2880
L6-20	208	20	N	N	4160	3328
L6-30	208	30	N	N	6240	4992
L21-30	208	30	Y	Y	10808	8646
L15-30	208	30	Y	N	10808	8646
CS8365 (Delta)	208	50	Y	N	18013	14410
60A-3Ph-Wye	208	60	Y	Y	21615	17292
60A-3Ph-Delta	208	60	Y	N	21615	17292

common non-US Plugs	Voltage	Amperage	PH?	Neutral	watt	80%
			3		100%	Watt
16A Blue (IEC 230V/16A)	230	16	N	Y	3680	2944
32A Blue (IEC 230V/32A)	230	32	N	Y	7360	5888
16A 3Ph Red (60309 3P+N+PE)	400	16	Y	Y	11084	8867
32A 3Ph Red (60309 3P+N+PE)	400	32	Y	Y	22169	17735
63A 3Ph Red (60309 3P+N+PE)	400	63	Y	Y	43646	34917

- 230 is noted, but sometimes can be 220-240v
- 400V is noted, but sometimes can be 380-415V

Note: A lot of datacenters (even in the US) are starting to deliver new space as 240/415V, due to better efficiency.

Understanding your edge traffic amount and mix

- First, understand what your total egress is to the internet. You generally want to find this and measure it in Gigabits per second. If possible, find your daily and weekly peak. If there are any special spikes, try and understand why they occur, (eg: do you send backups off to Amazon? Do you have special peak days, such as Black Friday, Super Bowl, Christmas etc.)

Understanding your traffic growth

Understand what your traffic rate has been, and project where it will go over the next 12 to 24 months.

Understanding where your traffic goes.

If possible, try and understand where your traffic goes. (is it to eyeballs? Which ones? Is it to content? Which ones?) Is it widely international (Asia? Europe? Latin America?). How much will you need to cloud providers? Will you need a dedicated cloud on-ramp (eg: AWS Direct Connect)

How much rack to rack interconnect do you need

How much rack to rack, (and egress) bandwidth do you need.

Ongoing refreshes

Usually, most hardware is refreshed every ~3 years. When you are planning your datacenter, make sure to take into account that you will be upgrading infrastructure. With a contract that can span, up to 15 years, you will want to plan for doing hardware upgrades. Hopefully this is as simple as removing old racks, and bringing new racks in, with various upgrades as needed (it's never this simple). Special care should be made regarding power draw, as you may end up with new racks pulling more power than before. This can cause cooling problems, as well as issues with the upstream RPP breakers. Also, try and have a reliable method of connecting the rack (eg: patch panels, etc. – these may also need to be refreshed as standards change).

Other cage specific items:

Make sure to plan room for on-site staff, room for storage, room on the floor for spares etc. And lots of other things, so that you can put that in an RFP for datacenters to respond to.

Cost estimates

As you start to put this together, and get quotes, you should soon be able to estimate what your 1,2,3,5,10 year costs of the datacenter will cost you.

This is critical to your finance team, as it will be one of the key factors in selecting the datacenter. You will need to understand: Rent, power cost, cooling cost, equipment, equipment support, bandwidth, incremental rack purchases, staffing, etc.

Also, keep in mind that there will be a period where you have both the datacenter, and the cloud infrastructure running at the same time. (Note: rushing the migration, may be a good financial decision, but can be a terrible operational decision. Make sure you have tested everything before cutover (including monthly and quarterly jobs).

Another thing to keep in mind, is that if you are getting to the point of considering moving out of a cloud provider, they may be willing to lower their prices, or re-negotiate aspects of their contract. In some cases, this has been a solution that companies have selected instead of building their own infrastructure.

Remote hands:

If you do not have staff on-site at certain times, the datacenter may have "remote hands", or you could contract with an unaffiliated "remote hands" company. The prices for remote hands are usually far more expensive than the cost of staff, and sometimes their SLA to actually be on the floor, may be longer than it takes to get staff there. However, in remote locations, that are unstaffed, this is the choice you will want to evaluate.

Summary:

A simple example of a datacenter ask is:

We need room for a 1MW space, with ~100 racks. 90% will be server racks, that pull up to 8-10Kw. We will also have network, and fiber racks, as well as storage bins, and tools on the floor. We will also need off the floor storage (approx 750 Sq Ft, and an office (approx 750 Sq ft.) We are looking for a 5 year contract, with the option to renew for 5 years, and 10 years.

Our racks are 30" wide, 84" high, 48" Deep, and weigh up to 3000 lbs.

Our racks will be fed from redundant power infrastructure, with CS8365 (30A 3 phase 208V circuits.)

(more detail in the sample RFP) - <https://github.com/cpc2018/my-first-colo>

Prework to Picking a Colo

The Colo Spreadsheet.

After you send out your RFP, Fill out a spreadsheet of the responses from the colos (see Appendices) so you can bake them off. Different things matter to different folks, (cost vs. scalability, direct access to providers vs backhaul. Metered vs. allocated power. Diversity, reliability, maximum Kw per footprint etc. All of these play a factor in what will be your final choice.

Power delivery

Understand how power is delivered to your cage. In the US, this could be delivered via multiple voltages (eg: 110, 208, 240, 400,415, 480). Usually, the plugs are all locking plugs.

For most power deliveries, you will want A and B power. (Ideally power should be fed from separate RPPs, and PDUs,) UPS and Generators, may be either N+1 or 2N.

Also understand if the circuits are delivered at floor level, underfloor or if they are delivered overhead. (Overhead is my strong preference).

Note: You should plan for all of your equipment to have 2 plugs (or an Even amount of plugs), and for all of your equipment to operate, if it loses 50% of its power feeds. Odd power feeds on equipment are usually a guaranteed method for future downtime.

Metered Power

To elaborate on metered vs allocated power. Metered power is where you will pay the metered rate for the power you consume, at the electrical meter for your space/set of electrical plugs. The colo provider will pass through the power cost to you, and then charge you an uplift for the cooling. At the end of the month, you will pay the “metered” rate.

Cooling costs.

In some cases, the cooling may also be metered (especially if you own a fully sealed space with dedicated equipment), but it can also be a fixed uplift of the power cost, usually tied to PUE.

With metered PUE, pay special attention to how the number is derived.

Are you paying for a prorated portion of the building, or just for your hardware?

Can other people impact your PUE bill? (eg: if someone has a poor cooling implementation, will you pay a portion of the building cooling, as a result?

If the building is partially full, and the air conditioning is not efficient, as there is always hardware that needs to run, in any building, will you have

to pay for that? (eg: in buildings designed for 1.X PUE, if it's still ramping up, the PUE can be 2.X or higher).

As an example, with fixed PUE, if the building has a 1.3 PUE, that means that you will pay an additional 30% of your power cost as an uplift for the cooling. This is probably the simplest.

Another option is if you have the PUE as a not to exceed. That way, if the building is less than the maximum PUE, that is your rate, and if it is over your contracted number, you pay only up to the contracted number. Depending upon the size of your build, this may be an option.

Allocated Power

Allocated power, is the other option for power, and is based on your contracted power. This is common in retail builds.

This is either at an outlet level, a rack level, or a space level, or some combination.

This is a use it or lose it amount of power. So, if you are contracted at 100Kw, you want your peak load to get as close to that as possible, without going over, while also having some headroom to grow and burst. This usually translates to setting your target at 80% of whatever your contracted amount is.

Allocated power is usually significantly higher than the cost of doing a metered power build. Metered power should be asked for where possible.

Side note: With all builds you should have an eye on doing proper cooling, so that hot air goes to the hot aisle, and cold air comes in the cold aisle. Doing appropriate airflow management (having all openings of the cabinet in use or blanked off), employing some level of containment, will all help keep your metered power bill lower.

GOTCHA: Make sure that the definition of a secondary circuit allows you to always pull power from the secondary circuit. Most pieces of equipment with multiple power supplies load-share (split power between both outlets). Some colo providers will not accept this and be "surprised" if you pull power from a secondary circuit, and attempt to charge you full price for this. Most datacenters with allocated power, will charge you a discounted fee for the secondary allocated power circuits (aka Redundant circuits). This is not an ideal solution, and is more costly than the metered power solution, but make sure you factor the costs in.

Key Dealpoints

When looking for your first space, the contract lawyer has many things to look for:

- Length of term – the number of months/years that your contract is good for.
 - o Make sure you know when the contract starts and ends.
 - o It may start, when the contract is signed, when the cage is built “Completion Date”, when you confirm the cage is built to your specifications “Acceptance Date”, X days after the completion date. “Automatic Acceptance Date”, when you have your first racks in place, or when you start pushing traffic. Note: the names in “quotes” may be termed differently under your contract.
 - o Make a shared calendar, and update your wiki, with key contract dates, (when the contract starts, ends and when you need to issue notices to renew, or cancel).
 - o You may also want to ask for an Early Access period – a time when you can do construction in the cage, but you are not paying rent.
- Noticing period for renewal / auto renewal.
 - o If you want to terminate the contract, understand what the renewal dates are. Some contracts have a very specific noticing window. Ideally, for a colo this size. it should be something like 30-90 days in advance if you want to cancel. If the vendor wants to cancel you, it should be 90-180 days, if possible.
 - o Also, if the contract was multi year, the renewal should now move to month-to-month. Also, there should no longer be a early termination fee, in a renewal phase.
- Early termination fees.
 - o Usually every contract starts with a termination fee for 100% of the value of the contract over the lifetime. If this is a multiyear, you can usually change this to be a sliding scale.
 - Eg: 100% of the value of year 1
 - XX% of the value of year 2
 - YY% of the value of year 3.
 - o For all renewals, there should not be a termination fee after the initial contract period is over. (Said twice for effect).
- Price escalators
 - o Most contracts ask to increase the price every year. While some things can increase (rent and electricity), things such as monthly cost of crossconnects, smarhands and network services should not increase if possible.
 - o There should also be a cap on maximum percentage increase (eg: not to exceed 3% annual increase). (note: if electricity is passed through (ideal) this may increase at a variable rate from the utility).
- Make sure that what you are signing for on day 1, is committed to throughout the length of the contract. If you are stating that you are wheeling fully assembled cabinets into the datacenter, and they are 89" (226CM) tall, then make sure that the datacenter provider is guaranteeing that there will be sufficient room to bring your rack in or

out during the entire contract. If not, that should trigger SLA credits, eventually leading to termination rights, allowing you to leave. It is STRONGLY recommended to incorporate the RFP as an attachment to the contract.

- If the datacenter is saying that they will have 24*7 onsite engineering and security staff, a web portal, the ability to bring in a 55 foot truck for packages, they offer garbage pickup, a break area, then all of those should be stated in the contract that they will be available during the life of the contract, as datacenters may try to back-track. (Yes, some of these are real world examples).

SLA Credits

- o There should be credits for temperature issues, (both too high and too cold)
 - There have been varying standards for temperature. As of this writing, it is recommended to follow the ASHRAE temperature ranges of 64.4F – 80.4F (18C-27C), with SLA credits accruing for when the cold aisle is outside of this range.
 - Make sure it is clear in the contract, where the temperature sensors are to be placed. The recommended placement of a sensor is 5 feet off the ground in the cold aisle. Not under the floor by an exhaust. Not far away from your equipment. Not right next to a cold air tile. (All real world examples).
 - Your SLA rights will usually be tied to the vendors Temperature sensor, and its placement. So make sure that they are placed in an agreed to, best practice location).
- o Credits for humidity issues (Too high, too low, and exceeding rate of change).
 - Again, you should follow the ASHRAE guidelines. (20-80% RH)
 - Also, make sure to confirm the humidity range for the equipment you are installing. Most devices “should” work to as low as ~10% RH and as high as 90% RH. Make sure that your equipment will have headroom, if you have a humidity event.
- o Credits for power issues (loss of either power feed, or both power feeds).
 - Datacenters may argue that losing 1 power feed is not an SLA event. However, even if your servers do not go down, the datacenter, still needs an incentive to fix the issue in a timely manner. Ex: If there is no credit given out if 1 power feed fails, then there is no reason to fix it. (Yes this has

- happened). While it may not be an “everything is down” emergency, there should be a credit schedule.
- If both feeds fail, this is a catastrophic problem. Even if power from both feeds goes down for just 1 second, your entire infrastructure is rebooting. Make sure you know if everything will boot up, or if you have to visit it in person. It is very easy to create race conditions where the site cannot come up. (eg: the DHCP server, needs to talk to the DNS server, but the DNS server needs the DHCP server up. Alternately, everything timed out to DHCP, because the switch, and routers took a long time to boot, so the DHCP packets were lost, and the servers now waiting for someone to reset them.) A 1 second power outage, can take hours to restore service.
 - This should have an aggressive SLA set of credits, leading up to a full months abatement (reduction of rent).
 - SIDE-NOTE: EPOs (Emergency Power Off). – The EPO button exists in a lot of datacenters. It is a simple way to turn off all power to the datacenter floor. This is usually used to turn power off in life saving events, to remove electricity from the room, if a fire breaks out, etc. However, the EPO is usually pushed accidentally, more than it is used correctly. This results in the room going off. When touring facilities, ask about EPOs, confirm that they are well signposted, behind plastic shields, that they have squealers (alarms) that go off if the shields are raised.

SIDE-NOTE: Remember, that if you want true redundancy, you will eventually need more than 1 physical location, as the physical location can be shut down.

- Credits for security issues. (Wrong people let in, too long to access cage etc.)
 - Most datacenters will tell you that it should “never” take 2-3 hours to enter a cage, when you have the appropriate tickets filed. However, very few of them will commit to a SLA. If possible, request credits to start accruing after people are stuck in the lobby for more than ~30 minutes.

Termination Rights

- Moving out of a datacenter is usually painful. The easiest way is to have a full second set of infrastructure, bring it up, and then decommission your first set. However, that is very costly. Another choice, is to bring up a skeleton second infrastructure, and move servers over (ideally by the

cabinet), by doing an ongoing shuffle. Painful, but it does reduce the financial impact. The worst choice, is to take an extended downtime, and move hardware. In any case, be prepared for items to fail in transit. Either way, It is a lot of work. However, sometimes, you will need to move due to issues with the datacenter.

- Termination rights, arise when things go so bad, that the contract allows you to leave.
- Examples of what should generate termination rights.
 - o Ongoing power/cooling issues – where the power/cooling is not reliable. Where the site has been down multiple times due to the inability to run the site reliably.
 - o Gross Negligence/Willful misconduct – As an example, if the Datacenter is not able to follow their own well-defined procedures that result in your site going down (eg: turning off the power to your space by accident), letting the temperature in your space get to ~100F in the cold aisle.
 - o Altering the site from what was agreed to in the contract, (eg: from a Tier 3 (Concurrently Maintainable) facility, to something that is not redundant).

The Datacenter, electricians, and cabling companies.

- When doing a large build, it is critical to understand who is doing what, and make sure that small (but key) tasks are not forgotten. Some jobs can be done by different teams, or worst case, every team assumes someone else is doing it. Make sure to have everyone on the same page. You should document (and have it in the contract) on who is doing the:
 - o Grounding grid.
 - o Grounding the racks as they are placed.
 - o Drilling holes in the concrete / floor tile
 - o Bolting down the cabinets.
 - o Actually plugging in the cabinets, and powering them on.
 - o Changing breakers in the PDU
 - o Providing the powered busbar, tapcans
 - o Who gets the monitoring feed of the busbar.
 - o Installing the ladder rack, and the fiber tray
 - o Installing the cooling containment system (if needed).
- Make sure there is a standing meeting with all parties, so that you can go over the issues, and everyone understands who has what task.

Choosing a rack integrator.

As you look to grow, one of the most important relationships to build, is with your rack integrator. They will be the ones getting you fully assembled racks to your datacenter, and helping you scale your infrastructure.

There are 3 basic types of integrator.

A boutique integrator.

- This is a small integrator, usually capable of turning out ~1-10 racks / week.
- They are generally highly flexible and able to turn changes around with the customer quickly.
- They will help put plans, processes, documents and designs in place.
- The customer can make lots of last minute changes, and work closely to have everything sorted out.
- The staff is well trained, and will alert you if they notice problems.
- The cost is usually higher per rack, as there are a lot more hand-holding, and detailed people looking at the rack.

A medium integrator

- This is a standard integrator, usually capable of turning up to 50 racks per week.
- They can be highly flexible and able to turn around changes with the customer quickly.
- There is a lot of collaboration putting in plans, processes and documents
- Some changes can be made, subject to restocking and parts availability.
- Most of the staff is well trained, and can alert if they notice problems.

(My ideal is a boutique medium integrator)

A large integrator

- This is a large integrator, capable of turning out hundreds of racks / week.
- They are very inflexible, and usually have very detailed rev control.
- They will expect the customer to provide extensive detail.
- Very little changes can be made once the bom is locked in. It may take ~6-12 months to cycle to a new revision
- The staff you are dealing with may not have the years of experience needed to recognize a problem, or have only been trained in a small aspect of the overall rack assembly.

- They may not know proper handling of equipment, (eg: fiber)
- They may not know how to test equipment (Eg: Fiber, SFPs etc.)
- The cost is usually lower per rack, but lots more problems are uncovered in the field.

Interview various integrators. Get a feel for what their facility looks like, and what they can do.

- They should have relationships with all of the server, memory, CPU, GPU, HDD, SSD, etc. vendors that you are using/planning to use. They may also have various suggestions, and trade-offs, for your implementation based upon experience.
- Relationships with some (hopefully all) of the network vendors you want to work with.
- They have multiple types of racks that you can work with, in varying widths, heights, and depths, depending upon what locations you are going into, and what you are putting in the rack.
- Understand problems with rolling weight, static weight, and can tell you what each cabinet they provide is rated for.
- They have the ability to test US, Asia, and EU voltages (eg: 208V 3-phase with 20,30,50, and 60 amp connectors for the US) and (380/400/415V plugs for 3-phase 16Amp, 32 Amp). They have all of the plugs that you have in your rack, able to test.
- They have the ability to ship your racks, securely, without being damaged, to your facility.
- They can quickly turn around any DOA part that they get from the manufacturer.
- They will send you a detailed inventory of what you received in a human readable format, that is easily converted to machine readable format.
- They should be able to provide you a rack within < 2 weeks of receiving all of the parts.
- They are able to get all of the suppliers of parts for your rack, to have parts show up on time to be integrated.
- They let you know of really long leadtime parts, of parts that are going EOL, or being replaced by a new part, and will work to get you the new part to test in advance.
- They let you know of upcoming pricing issues or potential issues. (eg: NAND shortage will lead to difficulty getting SSDs, flooding has led to a HDD shortage etc.)
- Your capacity planner, finance team, and the rack integrator are able to work on a forecast, so that you can have capacity ready to roll in, on a schedule, so you always have capacity.
- They can test everything to your specifications (eg: 6 hour, 12 hour, 24 hour burn-in, or X # of full memory passes etc.)

- It is recommended that every piece of gear coming in, is tested for some amount of time, especially if it is being integrated into a rack.
- They can make firmware changes and firmware upgrades. Over the course of your hardware procurement, your hardware vendor will deliver you hardware with multiple versions of firmware, (eg: BIOS, BMC, and firmware for all sub-components). It is the role of the integrator to buffer that, and deliver you a rack that is consistent every time to a “Gold Standard”. That means that when hardware arrives, it will get upgraded, (and maybe even downgraded) to a consistent version.
- They will also let you know when there are new firmware versions and when you should start revising your “Gold Standard”.
- Also, you and your integrator will want to look through your BIOS options to see if there are any options that should be changed from their default. Things like:
 - Power management / Power profiles
 - Server power on/power off behavior
 - PXE configuration and infinite retry options
 - And many more things. Your integrator will set all of these options on all of your upcoming deliveries.
- Understand the warranty, and advanced RMA options.
 - Will they go on-site every time there's an issue? (maybe if they are local?)
 - Will they ship servers/blades when there is an issue?
 - Are they your point of contact for networking issues/RMAs, or are you calling your networking vendor?
 - How long is the warranty, and what happens at the different year intervals?
- Most importantly, understand how much of the work will be done by you vs the integrator. Early on, when you are small, and still figuring out your first set of racks, this will require a lot of work with your team and the integrator. The integrator should be able to bring a lot of best practices to the table, while you will bring your business needs.
- You will want to start with a rack integrator who focuses on smaller (boutique) builds, as in the beginning you will be making a lot of changes to your builds, and improvements. You will also be certifying and testing new parts.
- Over time, depending upon your rate of growth, and the complexity of your build, it may make sense to look at larger integrators (eg: ~100 identical racks a quarter?) A larger integrator has more scale, but it

significantly less flexible. You will have to create and maintain the run book and keep a closer eye on quality.

- If you are eventually doing multiple builds that are dissimilar, it makes sense to stay with the boutique integrator. An example of this would be, if you were delivering multiple variants of racks, (eg: varying server numbers, different memory, cpu, drive counts etc.)

Cabinet Bring-in notes

There are a few things to note about a cabinet approach:

- You need to make sure that you get a cabinet that can fit through the doors (starting with the shipping door) and aisleways to your cage. (Know your vertical and horizontal clearances, especially in tight corners).
- You need to make sure that the floor loading of the datacenter, all the way from shipping to your cage is able to handle your equipment, or they have a solution to make it work (eg: metal sheets to reinforce the floor etc.)
- The problem you can face is having to tilt a fully loaded cabinet because the door is too low. (This is beyond the scope of this document, but, be very careful)
- Make sure your delivery company is highly competent, and has dealt with moving heavy equipment like this
- Your equipment should arrive on a air-ride truck equipped with a full-size lift-gate.
 - The lift-gate should be rated to support double the full weight of your cabinet.
 - usually at least 2 people should be arriving, to help deliver your cabinet. 4 is the ideal number.
 - your cabinet may show up on a pallet, or in a crate (this is common if delivery of your cabinet is > 50 miles from where it was made.)
 - Note: The cabinet, is not top heavy, its evenly heavy. Regardless, it may tip. If it looks like it's about to tip, DO NOT TRY TO STOP IT. Yes it may cost a lot of money, but you will not be able to stop it, and a sad event of losing your servers, could become a tragic event! (note: do not sign for it)

I cannot stress enough, that the relationship with your integrator is a two-way street. If you can forecast parts in advance with the integrator, you can have hardware (capacity) rolling in, in an easy to follow, methodical format, so that your site, always has capacity to burst.

Anecdote:

At a prior company, our integrator was able to work to a schedule of:
8 racks of X a quarter, delivered 2 racks at a time to 4 locations.

2 racks of Y a quarter, delivered 1st Monday of the quarter.

3 racks of Z a quarter, delivered 1 rack a month.

We also had 1 rack of X,Y and Z, available at the integrator as an emergency spare.

This meant that we were always adding capacity, according to a schedule.

When we ended up with too much capacity, we held off on racks 1 quarter down the line, so as not to affect current builds.

When we were growing faster than we expected, we were able to deploy the emergency spares, and then, increase the forecast.

Designing your first space

As you start to proceed down the path of building your own datacenter, start to plan out your space.

- Understand your rack dimensions, and how many you will need, day 1 and as you grow.
- Understand what your aisles will be, and how things like bins will stick into the aisle.
- Understand what types of connectivity you will need between the racks, and what the cabling for that will look like.

Know your server cabinet types (what power and footprint)

As mentioned earlier, try to order a consistent cookie cutter building block for your infrastructure. Ideally you should have all of your classes of rack, in a preferred rack, that can be cycled into the datacenter in an ongoing fashion.

- Understand the U level layout, the weight, the dimensions of the rack, and how much clearance you will have within the cage.
- Where cables run within the rack (power, network and management), and also where cables go from that server rack to other racks (eg: network racks).
- What the power consumption is worst case, expected peak, and steady state. You will want to base your plans around the expected peak, but with some headroom to burst and grow.
- When picking a rack, if possible, find a rack that is over 24" wide (eg: 28" or 30" wide). This will offer serviceability to the rack, so that you can manage PDUs, swap out rear facing equipment (Eg: network switches), and not have things like PDUs blocking heat from fans. That being said, a 24" rack can be ideal, as it fits cleanly on a floortile, and will cleanly bolt down through floortiles. (my preference is for 28 or 30")

Network Racks.

- Ideally, depending upon power draw, and redundancy needs, the network gear will be split into two (or more) racks, with half of the equipment in one rack, and the other half in a second rack. Ideally, you should be able to lose (or drain), one full network rack, and still keep the site running.
- Also, by using 2 network racks, if you ever need to upgrade, you can swap one rack out at a time, and keep the site running.
- If possible, you want the hardware you purchase to be able to grow. If you are buying a chassis-based router, keep in mind, that the money is mostly in the linecards, not in the cost of the chassis. Where possible, buy a chassis that allows you to expand (within reason) (eg: if you can buy a 4,6,10,or 12 slot router, but only need the 6 slot, it may make sense to buy the 10, or 12, so you can grow into it).
- If you have extra slots, and know what you will grow into, (eg: another blade of 10G ports). Then pre-wire for that, at the integrator, allowing you to quickly scale up when you need to add capacity. At this point, you

- should only need to have remote hands slot the linecard, to have the usable capacity.
- Depending upon the fiber needs for this rack, you should consider getting either a very wide rack, or connecting vertical wire managers to the network racks.

Demarc rack/Demarc Panels.

- The demarcation rack(s), is the idea of having all of your connectivity to the cage land in a dedicated location, and then the network racks connect to them. If you will have a large amount of crossconnects, going to multiple peers, this can be a great idea. If you have minimal crossconnects, this may be a poor use of space. Depending upon the space available, and redundancy requirements, it may make sense to have 2 of these. Ideally these will be the 2 racks, that never get swapped out during the length of your contract.
- The demarc rack is a low power rack, in case of DWDM, or non powered, in case of no DWDM. To allow you to swap network racks in and out, in a timely fashion, if you land all of your crossconnects in a demarc rack, you can easily swap the network rack in or out.
- Some datacenters also offer an in-the-wall demarc panel. This can be a good idea, but please confirm, in writing, how many crossconnects the panel can service, the fiber connector type that will be installed in the panel, and whether you can prewire it.
- With datacenters, they can hand off fiber in a multitude of ways. Ideally you should specify that you will be presenting your fiber as LC duplex/UPC connectors, and that is your standard connector.

How do I use my space? (denser servers mean more open space for storage).

- When you look for space, try to understand how dense you can be, and what you anticipate putting in there.

Each rack should have a

- maximum cooling load (how much the building is able to cool, directly to your rack, especially if you are in a row of racks)
- maximum power load (how much power you can draw within your entire space, how much you can draw at one physical rack)
- maximum outlet draw. (This is traditionally 80% of the rating of the circuit to your rack).

A newer (since 2010) datacenter should be able to support up to 10Kw. Older datacenters may have much lower limits. Some datacenters are able to cool 20Kw (and higher).

- Evaluate the various server types you want first. Understand how they can fit into a rack, their expected power draw, and how to network them. Also do this for your application servers and your DB servers. Try and keep your infrastructure to no more than 3 different types of servers. Things like a large GPU Compute server can be 4U, whereas some web servers have ~2 nodes in 1U.

- As you continue to scale, you should be adding cabinets by the specific type. (e.g.: a cabinet of DB, Web and App.) Having a 4th or 5th type, will only make this more complicated and costly. In the beginning it is ok to mix servers in the first few cabinets, but this should be the exception. Another good option, is to have your early racks delivered with room to expand, eg: by pre-wiring for planned expansion, so that you eventually have the homogeneity of racks.

Note: some things are inevitable, and you will have to do things like add ram or an extra hard drive to a few machines for one offs. (try to minimize this if possible, but if not, remember to have extra ram and extra drives in case this one off fails). Also, from a sparing and relaunch perspective, if a machine dies, and you need to reprovision it, it's much easier if you have an identical box already in your fleet, as opposed to having to manually upgrade an existing server.

Wire management

- As mentioned repeatedly, people will be working and triaging your infrastructure at all times of the day. Having cables dressed neatly, with both ends clearly marked, will make your life a lot easier.
- Cables do fail and will have to be replaced. If it's clearly labelled where it goes, its much easier. If it is also color coded appropriately, that will also help.
- Cables should be secured with something that is easily removable (Velcro), and not with something inflexible (zip ties).

Ladder rack, (and the fiber tray).

- As you need to connect cables between racks, the ideal solution is to have copper based cables go via a Ladder rack, and fibers go via a fiber tray.

Patch panels, pre-wiring

When possible, try to pre-wire for as much reasonable growth as possible. This will allow for you to quickly add linecards and connect them to pre-run, pre-labelled fiber where possible. Eg: if you deploy a 11 slot router, but only initially deploy 5 linecards, if you pre-run, pre-measure, and pre-label the cables for the other 6 linecards, you can quickly install the linecard when needed, and wire it up.

This can also apply to AOC and DAC cables, but do be conscious of the additional initial cost of a AOC/Dac cable, vs a fiber cable.

Bulk fiber to the meet me rooms, instead of 1 crossconnect at a time.

If possible, depending upon datacenter, you can prewire fiber to the MMR (Meet Me Rooms). Depending upon the panel, the cost, the labor, and your future growth, this should be done in 24 Strand increments.

This will allow you to have all your future crossconnects turned up, without someone working in your cage, for your cage to be a clean, well run area.

If your datacenter provider does 1 crossconnect at a time, they may be reticent to work on a live panel, and their ongoing quality may be poor.

OOB, (Out of Band).

- Where possible, try to have a viable OOB (Out Of Band) solution that allows you to remotely (but securely) connect to your infrastructure if things go down.
- If your routers melt down, you still want to be able to get to the console of them, or reset the power to them.
- If one of your switches reboots, you want to be able to log onto the console and see what is going on.
- If your devices provide output to the console, you want that output saved so that you can look at it later.
- Examples of OOB hardware include OpenGear, Lantronix, Digi, Avocent, etc.
- Do keep in mind, that if the entire building loses power you will not be able to reach your OOB solution.
- Also, think of what you should have serial and IPMI on. Do you put serial on every network device? Every PDU? That could mean that a server rack has 6 serial ports needed (2 for PDUs, 2 for production switches, and maybe 2 for the management switch).
- Does each server have a dedicated IPMI (iDrac) port that will be wired up? If so, you may need up to 2 management switches per server rack to support it.

Layout / End of row

- As you start designing your space, it may make sense to look at having an end of row presence from a networking perspective.
- It could be a place to aggregate your serial cables, (as one terminal server supports ~8 racks). Also the longer the length of the serial cable, the more cost, and also the signal may not be strong enough, if you haul it back too far.
- It could be a way to aggregate your IPMI network, (which is low bandwidth), so that the ipmi cables leaving the rack, don't go too far.
- This could be a dedicated rack, or it could even be an above ladder rack solution, (as this is fairly low powered).
- However, it may make sense to land all of this in your main network racks

Cabling types.

- When connecting your equipment together, you may want to look at different media types:
- DAC cables – are copper cables, designed to run at 10G,40G, 100G but at higher speeds have a distance limitation of up to 3 meters. These are

- highly affordable, but usually are only used within a rack. (this is highly recommended for pre-integrated racks).
- AOC cables – are fiber cables, with pre-terminated SFP/QSFP/QSFP28 (etc.) connectors. These can go up to 100 meters of distance, and are sold in pre-made lengths. This is usually a cheaper option than initially buying 2 optics, and a fiber cable in the middle, but can be hard to procure, hard to spare, and a pain to fix, if you get the lengths wrong.
 - Multi Mode fiber – Multi Mode fiber historically was cheaper than Single Mode fiber. With the move to things like OM4, and OM5, Single mode fiber has achieved parity, and in some cases is cheaper. Multi Mode optics are usually cheaper than single mode optics too, (at least as sold by most network/server vendors).
 - Note: with DAC, AOC and MMF, these all have speed limitations (eg: they are not future proof). With DAC, if you are replacing items a rack at a time, this is a viable solution. AOC and MMF may bring issues.
 - Single Mode Fiber- These were historically used to interconnect at the edge, as they were used to connect up to 10Km apart. Single mode fiber is highly versatile, and has been able to support 1gig up to 400gigabit and beyond. If you have a datacenter that may go through multiple retrofits, this is probably the best long term solution, as you will not have to keep upgrading the networking interconnect. SMF optics, as sold by most manufacturers are higher priced than the MMF optics. However, the volume on SMF optics is significantly higher. It is now common to see SMF optics cheaper than MMF optics, especially when dealing with 3rd party, or MSA (uncoded/direct from the manufacturer) optics, especially when factoring in the cost including the appropriate MMF cable.

Note:

Optic coding can be especially problematic.

Always test all possible permutations of DAC, AOC and optics, prior to buying large amounts of optics, or buying your hardware.

With the standard optical connectors (eg: SFP, SFP+, QSFP, QSFP28, OSFP (etc.)), the connector can be coded stating the manufacturer etc. Different vendors can choose whether they will let their device be compatible with the cable.

If possible, require all vendors to interoperate with “generic” (MSA) optics, with full functionality. This will be the easiest, as these optics can then form one common sparing pool. Otherwise, you may have a 100G-LR4 spare kit for multiple different vendors, and have to keep track of them.

DAC is generally supported at an MSA level by most vendors (this was not always true). AOC, and optics will by default want to be coded / sold from the vendor, but most vendors have an unlock code option.

Note: sometimes vendors will have an unlock code, but then also cripple some functionality (eg: removing DOM support). Make sure that the unlock is a full unlock.

Electrical notes.

- In the US, when selecting a space, this was usually delivered by multiple ~300KVA/300KW, PDUs (I'm using KVA and KW interchangeably here for convenience, but there is a difference). This meant that for most datacenters, to get to a ~1MW build, is really a ~1.2MW build, delivered by 8 300KW PDUs. (4 "A" feed, 4, "B" feed.)
- These may then have ~4-6 Remote Power Panels (RPPs) (aka: Sub-panels) (usually fed by ~225Amp circuits) that they feed, or the circuits may be directly connected off of the main PDU (especially common if using a bus-bar).
- You will want to understand the electrical layout at this level, and then decide how you will power the individual racks.
 - o Bus-Bar can be a great solution for your deployment, especially if you are changing your rack electrical infeed frequently, as it allows for a lot of flexibility. Eg: if you deployed a 30A 3 phase one year, you could turn that into a 60A 3 phase at the next hardware refresh, by swapping the tap can. (note: don't forget to make sure that you still have enough power/cooling to support that).
 - o However, if you do have a global standard of circuit type, that has head room to grow, a bus bar might not make sense, and a standard outlet can be a good choice. Evaluate, and keep an open mind.

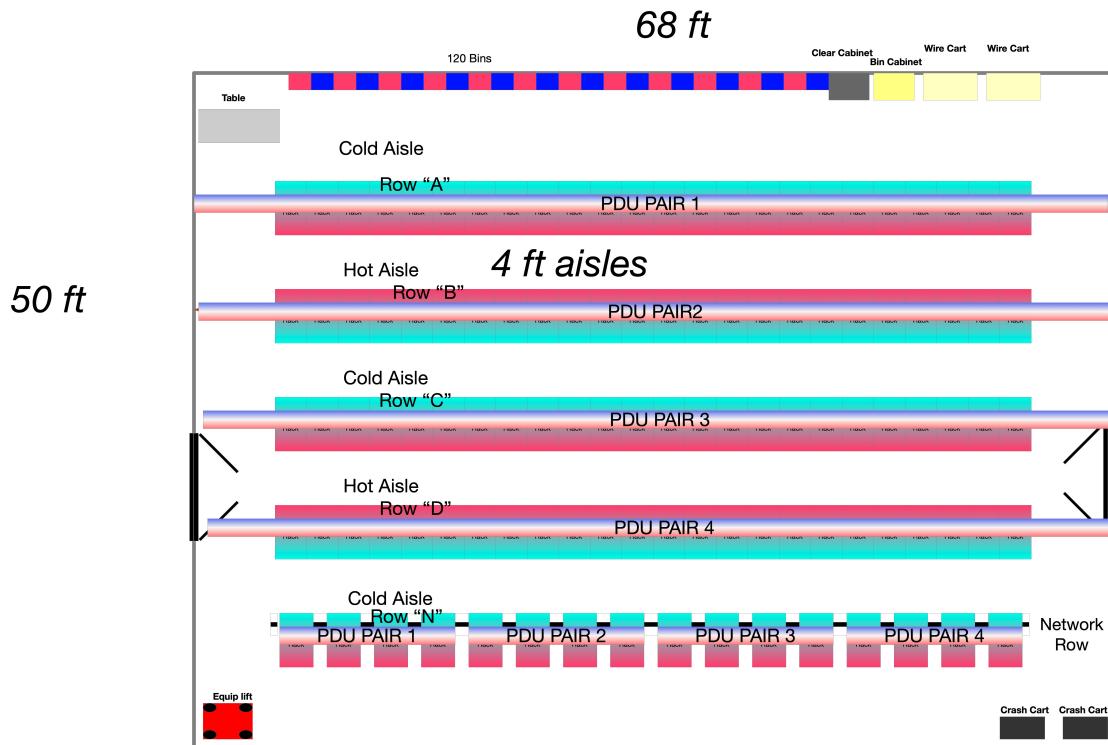
My preference is for Bus-Bar, as it brings the most flexibility, and future proofing.

- o At every point, you should make sure that you:
 - Know what the threshold is where the breakers will trip. (some of these breakers may only be 80% rated, or 100% rated).
 - What will happen to a rack, or row of equipment of dual connected equipment, when you lose a power feed.
 - Also remember, that you have to keep an eye on every Phase to make sure you don't overload it. You want your phases to be balanced (pulling a similar load), at the rack, RPP and PDU level. Ideally you will want this as something that can be monitored and graphed; each phase and amps

consumed at the rack level, the upstream breaker level, and the PDU level.

As a strong suggestion, try and make sure that your networking equipment, is split across as many upstream PDUs as possible. (eg: I usually try to have my edge, and spine routers, fed off of different PDU infrastructure, so that I can tolerate as many different types of electrical failures/maintenance as possible. (eg: if I had 4 networking spines, and ~8 PDUs, I would make sure that each spine is fed off of 2 different PDUs than all the other spines)

Here is a sample layout of a 1MW capable space (96 server racks, 16 network racks, fed from 4 PDU pairs).



Networking Connectivity Constraints.

When building a datacenter, you may have to be near certain providers (eg: cloud providers, your preferred upstream provider, your backbone provider etc.) and they may not be available in the datacenters that you have shortlisted.

Alternately, the datacenter that has all of the connectivity you need, can be either out of space, because it's that popular, or has the space you need, but at a prohibitively high cost, compared to your other choices.

First, with every datacenter, understand which carriers are in which building,
How close is it to where you are looking at?

Is there dedicated fiber to that building, available from the datacenter, and how is it priced?

Is it the same as a within the building crossconnect (cheap)

Is it a Dark fiber wavelength (potentially expensive).

Is the price affected by the type of circuit (eg: is a 1G, 10G, 100G xconnect the same price?)

Most datacenter providers can provide you with a matrix of where their fiber goes to other facilities.

Tip: use peeringdb.org to verify who is in the building. While it is not comprehensive, it will provide a good starting point.

Fabrics with dedicated capacity

One option that has recently appeared is that of a Network As A Service operator (eg: PacketFabric, Megaport). If they are in your datacenter, they may offer a connection to multiple network providers, to other lit buildings on their network, hopefully including the regional connection hub you need. They may also be willing to build into a facility, subject to a Non-Recurring Charge (NRC).

Fabrics with variable capacity

Alternately, some datacenter providers offer their own fabric to extend to their other in market buildings (eg: Equinix Internet Exchange), or to cloud providers (Equinix Cloud exchange).

Another option is Neutral Internet Exchanges, that build across multiple datacenters in a common market. An example of this is the AMS-IX, LINX, SIX etc.

Note that not all of these solutions are designed to provide you with full BGP Routes. That being said, depending upon the relationship you have with your carrier, and the fabric you may be able to negotiate something (eg: getting full routes via a vlan to a carrier).

One thing to keep in mind, is that these ports may have multiple sessions across them. (i.e. one network provider could have 50 BGP sessions up over 1 port). It

could be possible, that if they have a peak traffic day across some of the other sessions, for the port to be congested.

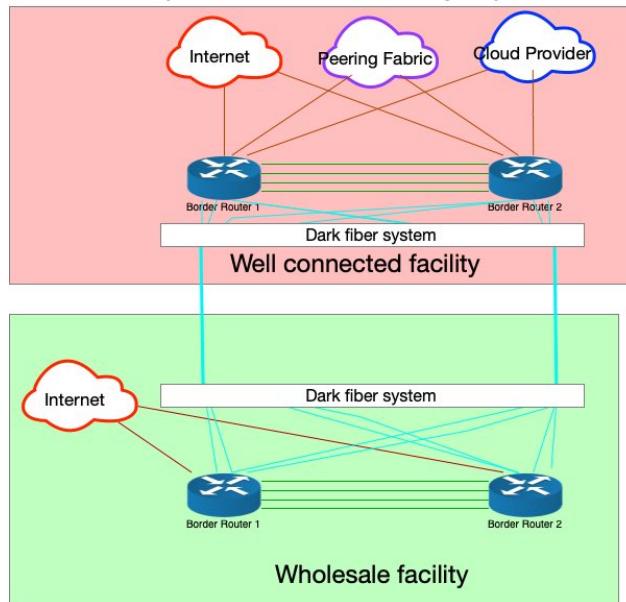
Multiple in-market colos (1 cheap, 1 expensive)

Another option is to take 1 small (expensive) rack in the well connected location in addition to the space needed to host your infrastructure, and use dedicated fiber (either DWDM, bulk fiber, or a network provider), to connect them together.

Depending upon how this is done, the costs can be compelling and interesting.

Do keep in mind that if you are deploying hardware in the 1 rack location, you will want to extend your monitoring, and OOB infrastructure there.

Generic Edge Topology Colo to Well connected building (Dark fiber example)



Warnings on fiber diversity.

Make sure if you are connecting 2 locations together, that you have circuits that are designed for fiber redundancy. You do not want a single fiber cut, to shut down your entire infrastructure. Ask for KMZs (readable by google earth) of where the fibers go. Confirm that they do not cross at any point, and keep ~20 Meters of separation.

When fiber arrives into the building, confirm that they arrive into different Meet Me rooms, and that they take different paths, to your suite, if possible.

Also, it is possible for diversity to disappear over time;

- If a fiber circuit is lost due to a large cut (storm, flood, etc.), sometimes the restoration is the most important. That means getting the circuit back

up, as opposed to getting it back up the way it was. It has happened in the past that two paths that were diverse, had a circuit fail. That circuit was then restored, but then shared common fiber pathing with the other circuit. Then a fiber cut happened that took down both circuits. Make sure to have your vendor check that your circuits are diverse, on a frequent basis (i.e. after a large outage and restore, at least annually, and any time the contract is up for renewal).

When discussing diversity of fiber, make sure to understand the distances involved. Usually, fiber should maintain 20M diversity where possible. Datacenters have claimed that there are diverse paths, except the paths were 3 feet (1 Meter) apart.

Networking Tasks

Selecting infrastructure

Depending upon your traffic needs, the number of providers, BGP route count, the size of your interfaces, etc. there are many different types of routers that can meet your needs.

Make sure to pick one that can run with dual power feeds and keep running if it loses one power feed.

Understand how the router can scale, what the roadmap is for future products etc. If you are purchasing a blade-based router, consider getting a larger chassis, so that you have room to expand in the future. Usually, the cost of a larger chassis is small, but gives you a lot more room to grow. Traditionally most of the cost of a large router is in the blades, and the optics, not in the chassis and power supplies.

As you plan for how much traffic your router can push, understand if you will be able to fill the rest of your cage with racks, and how that affects your router. Ideally have an architecture that you can easily upgrade to that allows you to fill up your cage.

Address space, ASNs etc.

When you are looking to bring up your own infrastructure, if you have multiple upstream providers, the common way to connect to them is via BGP, with your own ASN, and your own address space.

ASNs, and IPv6 space are issued by one of 5 RIRs (Regional Internet Registry). These are: ARIN (north America), LACNIC (Latin, and South America), AFRINIC (Africa), RIPE (Europe), APNIC (Asia and Australia).

This is a bit of a chicken and egg problem, and may be different depending upon your local RIR.

It is very important that your paperwork is accurate at every step. Also, the RIRs have very detailed, steps on how to contact them, what is needed, etc.

The steps in getting this working are usually:

- Get an RIR Account. Have your appropriate business credentials if needed (eg: articles of incorporation).
- Have at least one signed upstream provider, (signed contract), or have an operating circuit.
- Request an ASN.
- Be issued an ASN.
- Bring up circuit, showing your ASN as visible behind your upstream providers.
- Fill out IPv4 and IPv6 registration paperwork with your local RIR. Note: Make sure your forecast is correct, and you understand the announcement minimums (eg: IPv4 minimum advertisement is /24, and IPv6 is /48.)
- Be issued the IPv6 block.
- You will probably need to procure the IPv4 block via an IPv4 transfer.
- Advertise the new block
- Migrate to the new block (if you had a temporary allocation).

- Sign up for an account at peeringdb.org. Request peers / interconnect as needed.

Other considerations

Depending upon where you are moving from, make sure you have a reliable path to your existing site, understand how the two sites will function during the bring-up, go live, and afterwards timeframes.

Systems Tasks

Selecting infrastructure

Depending upon what types of servers you need, there are multiple vendors out there that sell hardware that meets your needs. If possible, you should try to evaluate all the different hardware you can, eliminate what does not work, and find a viable solution. Your integrator(s) should be able to provide some insight as well.

Remember to make sure that the hardware will fit within your rack, will provide you a path forward for 3 years etc.

Also, if you can, test and understand your application on sample hardware. Understand the tradeoffs, limitations, and costs of the platform you pick.

For example, It may turn out that the dual socket server, is not best for your application, a single socket may be better. It may turn out that the cross CPU latency (eg: QPI) is a problem.

Memory selection is important too. I generally recommend to get denser memory, so that you have room to expand down the line, while at the same time making sure all memory channels are used. However, this may have impact on overall memory speed, memory bandwidth etc.

Come up with qualification criteria for hardware. Understand how many transactions you get out of the different servers vs. what it costs, (including CPU, memory, drives etc.), vs power consumption.

Also, then make sure that this translates to how many nodes you can fit into a rack. (eg: if you only have 10Kw usable in a rack):

A 300 Watt node: - 33 nodes / rack

A 200 Watt node: - 50 nodes / rack

A 100 Watt node: - 100 nodes / rack (but you will run out of space in the rack first)

Virtualization, containers etc.

Depending upon your infrastructure, and your application, you will want to look at ways to maximize the usage of your infrastructure. With the advent of virtualization technologies, and the desire to buy similar servers, you can no longer have dedicated physical hardware for your low CPU services. E.g. neither DNS, mail or DHCP servers need 40 cores each to run infrastructure.

As you look to your applications that you will be deploying at the datacenter, make sure that you are deploying them such that your CPU, memory, IO, and network on the servers are able to be balanced and take advantage of the hardware.

Note: if you have an application that can take full advantage of a server, it may not make sense to virtualize the server, as it is fully used. But, make sure you can move/repurpose it etc.

Installation and imaging

With all of the servers, you will want to make sure that you can repurpose and reprovision them should you need to, as well as quickly add new capacity when it shows up.

Plan for capacity, issues, and scale

As mentioned earlier, be conscious of how much headroom you have on your infrastructure. Know what your busy times are, and how much you can burst. Also, keep in mind how long it can take to get hardware. You never want to be caught in a crunch where you are trying everything to keep the site running, and for it to fail.

Also, if possible, profile code releases and deployments to your infrastructure before they go live. If they result in needing more processor time to do the same amount of work, what that means is that it will eat into your headroom.

Have good logs, good alerting, and a way to triage the issues you are seeing.

Have a way to quickly roll back bad deployments to a known good state if you encounter a problem.

It is beyond the scope of this document, but there are interesting virtual and container technologies, that may allow you to have infrastructure that is easily portable/scalable both in the datacenter, and in all the main cloud providers. With appropriate planning, it may be possible to burst into the cloud, to overcome shortfalls in capacity. It may also be possible to have an easier migration into dedicated hardware, if you have this architecture to start.

Also, things will fail, and things will need to be patched. You should always have headroom to support server failure, and even rack failure. Also, assume that you will have to drain infrastructure to upgrade or replace.

Documentation!

As you build out your infrastructure, there will be a lot of paperwork generated. From contracts, purchase orders, site notes, various plans, etc.

- The Wiki, or: How I learned to stop worrying and love documentation!

In the book the Cuckoo's Egg (By Clifford Stoll) he mentions that if it's not in his log book then it doesn't exist. Similarly, if what goes into the colo is not documented, then it doesn't exist; you don't know it's there, and you will be unable to find it if needed. Time will be lost when trying to triage.

One of your first steps should be to start creating a wiki, [or online folder (eg:Dropbox, Google Drive etc.)], to document various aspects of the colo.

Things you should want to document:

- Important business paperwork
- Contracts!
 - o For network circuits
 - o For the datacenter spaces
- POs!
- Questionnaire Responses
- Evaluation notes of all the sites visited
- Contacts of folks related to the project!
 - o Datacenter managers, escalation points
 - o Cabling, electrical, cooling vendors
 - o Parts vendors (Grainger, Anixter, Graybar, CDW, etc.)
- Addresses of the project
- Access requirements, and special incantations needed to get into the site.
- A spreadsheet of all the people who need access. This will become your master list of access, (some datacenters will want you to send them a sheet of who gets access)
- Every bit of information about crossconnects. (crossconnect IDs, order numbers, ports take on the panel, who pays, connector type, your local Port, their remote port, IPv4, IPv6 allocations etc.)
- The building and cage layout (ideally, near, mid and long term).
- contact information for all your peers, upstreams etc.
- a 911 page (the absolute basics: who to contact in an emergency, how to get in, etc.) Who to escalate to, and how soon.

-Cabling summary

I recommend you have documents of logical and physical layout, for racks, servers, network, out of band, management networks etc. Also, plan out every cable connection. There may be things that you miss, but you will want to keep revising them, until you cannot find any issues.

There are a few tricks to making things simpler; You may want to get color coded cables. That way you know things are split appropriately. (eg: I usually have black and red power cords, and my black goes to my primary PDU, and red goes to my redundant PDU. You can also do this, (with some planning) with fiber, and

network cable. (It is possible to order SMF cable in a color other than Yellow, but it will take time).

If you can get your cables pre-labelled, that helps a lot! Bonus, if they are packaged in a clearly marked box!

Also, when plugging things in, have your patching matrix printed on a large sheet, (eg: a C (or D) size, (A2 (or A1) size) printout, and have that near where you are working as a reference). This will make things go faster.

-The spreadsheets

Not everything fits into a wiki, some things should go in a spreadsheet; (side note: A machine readable database would probably be a better long-term strategy, but is more difficult to implement)

For example:

- Bin layouts.
- Inventory of things in bins
- Inventory of things not in bins.
- U level layouts of hardware.

- IPv4 and IPv6 allocation spreadsheets. You need a place to keep track of ip ranges. (whether this is done via a spreadsheet, a IP allocation tool etc., it should be written down somewhere. (You should never want to follow the “ping for that”, or “if it’s not in the routing table, its free”)

- Important business paperwork

If you do not have existing business relationships with most of your vendors, you, or someone from finance, will need to set them up.

To set them up, you should gather the following bits of information:

- A copy of the first page of your articles of incorporation
- A copy of your state business permit

Also, it is recommended to ask finance to create a 1 pager for your to set up credit terms:

This should include:

Your Tax ID (EIN)

DUNS # (if within the USA)

State of incorporation (if within the USA)

3 references of vendors (eg: landlord, and 2 suppliers)

Bank contact info

- Keeping track of Contracts

For contracts, you will want at least 4 different things (the final red line, the pdf for signature, the 1 party signed copy, the fully countersigned copy). Legal will be asking for this, so try to stay ahead of them.

Ideally have a copy of all of the red lines, so you can see the progression. Also, depending upon who signs second on a contract, you might not always get the countersigned copy back. Using an online signing program (eg: DocuSign, HelloSign), will ensure that both parties get a countersigned copy.

Tip: All the contracts have different noticing terms, and special dates. A shared calendar (or spreadsheet) with start dates, renewal dates, escalator dates, end dates etc. should be kept).

- Keeping track of POs

As you are starting with your colo, you should be keeping track of your purchases. Finance will want to know what you have purchased, and you will want to know what doesn't show up.

At the bare minimum keep track of all the POs you have issued that relate to the datacenter.

Best case, save all copies of orders in a common easily accessible place. An online cloud file system for this really helps (eg: Dropbox, Google Drive etc.). Also, have a rollup spreadsheet if you can, with tabs showing the expenditures to underlying vendors. Please see example in appendix.

In a perfect world, deal with vendors and resellers who provide real time tracking information on a per part basis. (Imagine what it is like ordering from Amazon and expect that out of your vendors.)

Some datacenters are sticklers for arriving equipment. If your reseller cannot provide accurate dates for when things are arriving, your packages may get bounced! Make sure you can get up to a 24-hour warning of incoming parts.

- Questionnaire Responses

Prior to visiting a DC, send them a series of questions in advance. Be clear about the amount of space you are looking for, how much power and weight your cabinets use. Confirm that they can meet your needs. And then do an on-site walk to double check.

Note: because of the value of the contract, Datacenters can sometimes embellish the truth significantly. **Always do an on-site in-person evaluation.**

Examples of why Datacenters may fail your selection:

- No space for your deployment.
- Not enough power for your deployment
- Not enough vertical clearance to wheel in your cabinets.
- Poor physical security
- Not designed to the level of redundancy you are looking for (eg: you are looking for a Tier 3 facility), but the facility is a Tier 2.

- Evaluation Notes

Not every datacenter can meet your needs, and it may take visits to multiple datacenters to figure out which is the correct one.

Having a set of notes/checklist to refer back to will be a huge help for when you do your site selection. (see Appendix for links)

Examples of issues found in the past:

- Fiber not redundant within the building. (Primary and Redundant paths crossed)
- Fiber not redundant when leaving the building. (Primary and Redundant paths crossed)
- Carriers were in the building, but no carriers were available in the datacenter vendor's suite.
- Vertical clearance issues for racks at various doorways.
- Horizontal clearance issues, when going around corners. (Unable to turn racks).
- Loading dock not able to handle large truck, due to being in an underground garage with limited clearance.
- Overly cumbersome to get equipment into the building (eg: excessive Masonite requirements)

- Contacts

Everyone who will be successful to the bring up of the datacenter should be documented, so that you, your team members, whoever is oncall, accounting etc. can reach them.

TIP: As you may find yourself having to make multiple phone calls to your vendors, add all the contacts to a .VCF File, and put the .VCF file on a common share. That way as you add team members, they will be able to quickly come up to speed, by importing the vendors to their phones, and then be able to contact the vendors.

- Addresses of the project

Make sure to write down the full address information, making sure to note the shipping address, cage number etc. Also, make sure to note shipping restrictions (eg: all packages need tickets, 24 hour notice needed prior to arrival, nothing in excess of X pounds without a ticket etc.)

- Access requirements

Getting into a datacenter can be tricky. Even if you have all of your paperwork in order, it can take anywhere from 10 minutes to 3 hours to enter a datacenter the first time you visit there.

As you, and your team visit, make sure to update your notes about what works to get into the facility.

- Some datacenters have multiple security desks, (eg: a landlord desk, and a datacenter tenant desk)
- Some datacenters require you to enter via different lobbies at the time of day.
- Some require tickets and forms in advance. Some do not.
- Also, datacenters will require different amounts of information. If you will eventually be going to multiple colos, it is best to gather as much info as possible.
- Make sure to open all appropriate work visit, handscan enrollment tickets etc. that you may need BEFORE going on-site. Have the tickets ready when you walk in.

TIP: The Daytime shift, usually has the security staff that has done the most “new user badge” issuances. It is highly recommended to make the first visit to the datacenter on a Weekday during standard working hours. (Otherwise, it can be up to 3 hours to get in).

- Keeping track of inventory (servers, network gear).

Coming up with an inventory system for your servers, and network gear that captures everything you need to know is difficult. It involves providing data to multiple teams (Systems, Network, Datacenter, Finance). Various companies try and sell products to do this. However, most implementations fail, because it's not agreed on what data is collected in the beginning, and how it should be used. When the data is suspect by multiple teams, it will not be adopted, without all of the data being scrubbed again.

The data collected should include:

DC #, Cage #, Cabinet #, U#, location in the U (Eg: slot # etc.)
Server Type, Server hostname(s), serial #, Asset #

Chassis (eg: if blade server etc.), slot #, orientation in chassis,
CPU: # CPUs, # Cores (total), # Cores / CPU, CPU TDP, CPU Freq.
SMP (aka: Hyperthreading) on vs off.
Memory: total GB, # DIMMS,
Each DIMM: DIMM type, DIMM Speed, Manufacturer, PN, Serial #
Drives: total Drives, Drive raid configs:
Each drive: total GB, status (on, off, failed, hot spare, etc.) capacity, PN,
Serial #, Manufacturer, PN, Serial #.
Network:
Each nic: interface name, capacity, negotiated speed, Manufacturer, MAC
Address, Allocated/Reserved IPv4 and IPv6 addresses, upstream switch, upstream switch port,
optical light Rx, optical light Tx (if using optical).
Fans: total Fans, status (up, down, failed), fan speed.
Power supplies: total power supplies (up, down failed),
Each power supply: supply name, PSU efficiency, upstream PDU, upstream
PDU Port, amperage/wattage,
Other rack info: Integrator, support contract #, support contract expiration,
support contract level
Key dates:
When the cabinet was delivered, when the rack was handed to networking,
when it was handed to systems, when it started pushing traffic. (These are dates that finance will
want to determine the depreciation of the hardware.
Financial data: - overall cost, depreciation length, remaining value of hardware.

Also, make sure that this data is visually representable; so that you can see a
mock up of the rack. (both via a web page, and even by ASCII)

Most of this data will also want to go into an alerting, reporting and trouble
ticketing system. Also keep in mind, that in a remote datacenter, you will need to
provide physical detail to people who cannot log into the systems.

Asset tags, are strongly recommended, provided that they do not block
airflow on equipment. If possible the asset tag should also be placed on the server
as a DMI string too.

- Keeping track of inventory (bins and sundries).

Non active equipment, also need to be tracked, mainly so that when you go to
the datacenter, you know you have the correct amount of tools and spares.

An inventory should be done every 3 months, (if you are visiting frequently),
or every time you visit, if visiting less frequently. Be especially conscious about
what smart hands is consuming as well.

Tip: if you are performing a remote hands ticket to swap a
consumable: (Optic, DIMM, Hard drive etc.), make sure to ask the
provider how many spares are left, so that you can update that.

Side note: If you have parts that the datacenter also uses, make sure to label your equipment CLEARLY that it is yours. While you should not put your company name on there, put your cage # etc. on there. Things that like to grow legs, include ladders, garbage cans, fiber cleaners, screwdrivers etc.

- Consistent Naming of gear.

All pieces of gear should follow a consistent naming scheme.
There are varying ideas around what follows a naming scheme. Some options are:

AAA##-R###-U## - This is probably the most impersonal, but probably the most scalable.

AAA## - Unique identifier code for your colo. A lot of folks use IATA Metro codes, and 2 digits for the datacenter in the market: (eg: TY001, NYC01, CHI01)

[https://wikitravel.org/en/Metropolitan Area Airport Codes](https://wikitravel.org/en/Metropolitan_Area_Airport_Codes)

R### - Rack number

U## - Position in the rack. (Make sure you have a rack that has numbered U's (or get a sharpie!) (note: U numbering should start from the bottom, and work up.).

So a host in San Jose, in rack 102, in U position 5 would come out as:
Sjc01-R102-05.

There are a few downsides to this name, it says where the server is, but not what it is. Is it a web server? Is it a DNS server? Is it a DB server? A VM cluster? Is it a 1U? If it's a 2U, is 05 the 5th box in the cabinet, or is it on the 5th u? (All things to figure out).

On the flip side, some of this is an advantage:

- If it's a web server, and it becomes a DNS or app (or something else), then you don't need to relabel it. Since it will most likely be reconfigured remotely, the label will probably never get redone and you'll end up telling someone on the phone to do some work on DNS01, when it is labeled as web33, and get frustrated when they can't find it.
- For the type of server detail, a lot of information can also be put in TXT dns records, (only on the internal view though), and other names can be put into CNAMEs, but make sure to send all information when opening tickets.

Other naming systems can be:

AAA-TTTT##

AAA -Unique identifier code for your colo

TTTT## - function type.

Regardless of the method you choose, please make sure that your network devices, and your monitoring systems are always up to date on this.

Also, you should have the ability to blink this server, using something like the ipmi identify option. Its very easy to identify the server when you say "look for the blinking light!".

Note: make sure that your blinking lights expire (eg: after 12 hours) (or are turned off by an automatic job (eg: at 1:00AM)

Cage Sundries (all the things to keep the cage clean).

The idea here is to help keep your cage clean. You want things to be able to be found easily. You want to have the tools needed to work safely and restore the site quickly. You want to know that you can have someone walk in the cage and find everything they need to do their job. Remember that not everyone who goes in your cage may work for your company, some people will be employees of the colo, or people delivering gear to your cage.

Take a close look at appendix A

The easier it is for them to get their work done, the better things will be. I've put some critical items here.

The labeler!

The first thing on your shopping list should be a labeler. This is to help you identify gear. When you are starting out, this might seem like a frivolous idea, but as you get big, you'll start wondering, "what is that piece of gear", "where does that cable go to", etc.

One of the things to look for in a labeler is for PC/Mac connectivity. If you have a spreadsheet (see inventory section), you can with a bit of "concatenate" magic, make a lot of helpful labels into a CSV or Text files, that you can then mail merge to a label printer. What this means is you can create labels hundreds at a time, instead of keyboarding it.

An example of a labeler that does this is the brother PT-E550W (note: the 550W has a "half-cutter" which is a big help, or the PT-9600 (note: historically some of the lower end ones have only PC support and not mac support)).

My preference is for the PT-E550w, as it supports auto-ranging power (120-240V). The E550W is a successor to the 9600, but, it has less printable area than the 9600. (so if you want to print on a 24MM label, you can have to shrink it a bit.)

Other labelers to look at include the line of brady or Dymo labelers.

Another thing that is recently available is the ability to print out barcodes on some labelers. As a result, you can (in the barcode) provide links to a monitoring system. This would allow you to scan a barcode on a cable, and determine:

- is it in maintenance mode? (is this the one I should be unplugging?)
- Is it live and pushing traffic
- where does it go to (pull up a full inventory of the cable map).
- and probably a bunch of other things.

I am not aware of a monitoring system that does this, but this functionality would help eliminate operational issues.

A labeler that does the QR code (2D barcode) printing is the Brother PT-E550W.

Each label should have two pieces of data, a source and an end.
Using your agreed to, consistent naming system, print out labels (by the reel).

There are various opinions as to how to make labels. Some folks like the wrap around labels (see: brady), some folks like flag labels (eg: brother). Some folks like printing the label twice and folding it over on itself (so you can see it no matter which way it is facing. Regardless of what you choose, make sure you have a label.

* My preference is for a twice printed flag style label, using cable grade or high adhesive tape.
(eg: brother TZE-FX251 tape)

Backbrace

- Your back is fragile, and many things in the datacenter are heavy. It is recommended that you purchase a few back braces (of the appropriate size and rating), and portable carts, and hydraulic lifts to move heavy equipment around. It also is better to the company if you are able to work throughout the bringup of the cage as opposed to being of physical therapy, and unable to lift anything.
- sample back brace and cart equipment are listed in the appendix.

- vertical storage (Bins, more is better!)

- There are a lot of different things that go into building a cage. Cables, screws, tools, network and server components, and all of these could be needed in an emergency.
- Always allocate space for bins in your design. Try and lay them out in a consistent way, so that as you add more locations, you can copy this design. That way, when you add multiple locations you are ready to go, and there is not a lot of training to do.

If possible have large bins, and small bins. You will have more small parts (eg: optics, attenuators, tools etc.), than you will have big parts.

Examples of bins and their layout are listed in the appendix.

- where do I put blades? (mobile shelving)

For large items, (eg: a blade for a router), a spare switch, spare server etc, you should purchase mobile shelving, so that you can have a place to store spare blades when needed. These unfortunately take quite a bit of room. If possible, build these into your space plans for the datacenter, or procure on-site storage space at your colo.

Example listed in appendix.

- I need to do maintenance on a server (portable crash cart)

Sometimes, a server just needs the personal touch, whether its adding ram, swapping a motherboard or other component. However, space is at a premium. If possible have a portable work table, that can also function as a crash cart, so you can troubleshoot a server when needed. It should have monitor, keyboard, and common

tools. Sometimes a datacenter may provide this, but it is usually a shared resource, meaning its never available when you need it.

Example listed in appendix.

- I need to sit here and fix a lot of stuff (desk and chairs).

In the very beginning of a colo, there is a lot of space, due to spare rack footprints, room for growth etc., and you will be doing a lot of work there. If possible, procure some folding chairs, and some folding desks. This will help you get things done in the cage. As time goes on, this may become less of an issue, but the investment will help out in the long run.

Example listed in appendix.

- Storing cardboard!

- Cardboard is generally not allowed in the datacenter. (It can be a fire hazard.) If possible, place cardboard that you need to keep in a dedicated storage area that is separate from the datacenter, (if a storage area is part of your deal.) If not, you may be able to store it in the building shipping location, with support from the building. Very large items (eg: specialized crates) fall into this category.

- If you have items that need to go into your space, (eg: cardboard sleeves for spare network blades), make sure to work it out with the building. If all else fails, various shelving catalogs can come to your rescue. Locked metal cabinets, may allow you to store cardboard within them, when on the datacenter floor, if allowed by the datacenter.

- common tools (for mostly everyone).

- some common tools to think of for the cage. (actual part numbers and links are in the appendix).

- Wire cutters, pliers, drill, spare drill bits, labeler, label tape, fiber tester, fiber cleaner, light meter, screws, small hand screwdrivers, socket set, a rubber mallet (some shelving needs this for assembly), extension cord, boxcutters, earplugs, a 2 foot step stool, an 8 foot ladder, work cart, portable shelving, folding table, folding chairs, spare AA batteries, Back supports, equipment lift, sharpies, first aid kit, tape measure, back braces, tile puller (if applicable), zip ties, Velcro, 9 pin - RJ45 connectors (M and F),

- extra gbics, (of all the types you use) sfps, sfp+, QSFP, QSFP28 etc.
- extra copper cables (cat 5/cat 6 (what you use))
- extra fiber cables, and fiber panel connectors (what you use).

- Who sells what gear?

- Grainger www.grainger.com - sells a lot of the general infrastructure stuff. - bins, common tools, shelving etc. Since they do not specialize in networking stuff, you will need to look at things with an eye on potential usability. Their web site is amazingly complete, and everything can be purchased online. Also, getting credit

terms, if you are a small player is fairly easy. Part numbers of things I commonly order from grainger are in the appendix.

- Anixter www.anixter.com - sells a lot of the networking sundries (copper/fiber cables, testers, adapters etc.) When setting up an account with Anixter, get an account on their eanixter portal - www.eanixter.com On this site you can order (nearly) everything that they carry. If something is not available, as Anixter to add it to eanixter.

- Graybar www.graybar.com - sells a lot of the networking sundries, similar to Anixter. Their online portal is at: <http://shop.graybar.com> Graybar also has a lot of physical counters, so if you need common parts, and have a car, you can drive there and get them on short notice. Note: getting credit terms with graybar can be substantially difficult.

- CDW www.cdw.com - sells a few of the general components that the other vendors do not carry (eg: labelers, label tape etc.)

- Quail www.quail.com - for the special power cables you need, Quail has some of these. A lot of network equipment you purchase will come with the wrong power cable for your infrastructure, so it helps to have your own power cables on hand. Also with the advent of different colored power cables, you can easily ensure that a redundant power supply does not get plugged into the same strip as a primary power supply. Note: you should make sure that your power cables have retention on both sides! This may be accomplished by grommets, springs, or latches. Some of this is cable specific. Some is PDU specific etc. Whichever you choose, make sure all cables are secured.

- Fiberstore – www.fs.com – A vendor of Fiber cables, fiber cleaners and other fiber components. (not recommended for optics).

- Flexoptix – www.flexoptix.com – A vendor for a wide choice of SFPs, DACs and AOC Cables. They also offer a programmer to reprogram your optics to the correct ID code if needed.

Testing, go-live, and what's next.

Testing

Test as much as you can before you go live. If possible, try and emulate as many different scenarios. Things such as failures of an individual hard drive, and individual node, a rack, and even the datacenter, will give you an idea about how your infrastructure responds when things go out.

Are you getting the right types of alerts? Are people being woken up when needed to? Do you have the information needed to triage appropriately?

Do you have the right methods to communicate together, (a chat bridge, a voice bridge) etc.

If you have to leverage remote hands, do you have pre-made scripts about what you need them to do.

Are you able to load-test the site?

Going Live.

One of the most challenging things is to go live, as it can be quite a complex feat. You will probably run things simultaneously if possible, if latency, security restrictions etc. are not an issue. Consider moving services one at a time, with minimal downtime. Have detailed roll forward, and roll back plans. Try and move a small percentage of your user traffic to your new site first, so that you can do a gradual deployment.

What's next

After you have moved your infrastructure, and the site is running reliably, you move into the long-term operation of your space. This is a multifaceted set of issues. You will always need to have spare capacity around for headroom (or bad pushes). This translates into extra servers, network capacity, power and footprint for additional racks, or a way to burst into the cloud. When you are running out of space, you will need to have a solution to keep the site operational, (expand, move etc.)

Also, keep in mind, that while it is unlikely, you can lose a single building (eg: earthquake, fire, natural disaster, etc.), and at some point, you will be expected to have a backup set of infrastructure should your primary datacenter fail. The long-term goal should be that should any of your infrastructure fail, including an entire datacenter, that your users do not notice, and that your site continues to function. This is something that should be practiced and improved upon.

Hardware is now moving into a lifecycle. Server components will age out, (eg: newer CPUs, memory, SSDs, motherboards, newer network interfaces etc.) Make sure to test and certify these, before your old platform is EOL.

Newer technology is always coming out, and this may affect how you build and operate your infrastructure. Keep an eye out for ongoing improvements

allowing you to increase reliability, reduce cost, and reduce footprint. Also, if you did move out of the cloud to operate this infrastructure, keep in mind that there will be continuing price erosion of the cloud services, so your infrastructure needs to show ongoing price improvements (eg: by getting more performance out of your servers, by reducing hardware costs, by reducing operating costs, such as cost of transit and backhaul etc.)

Anecdotes and Warnings

This section didn't fit nicely anywhere, so here are some examples from the trenches of where I encountered issues over the years.

An explanation on Tiers

Most datacenters are defined as "Tier 1, to Tier 4", with most datacenters a company would evaluate, being in the Tier 3 or Tier 4 realm. This is defined in the TIA 942 paperwork. I highly recommend downloading this and referencing the document during your datacenter selection.

There are a few key takeaways. A datacenter is the lower of each of the subtiers; Electrical, Mechanical, and Architectural. (eg: if you had a Tier 1 Architectural, and Tier 4 Mechanical, and Electrical, it is a Tier 1 facility.)

A lot of facilities state that they are "Tier 3", but make sure to ask, if that's Architectural, Mechanical, Electrical, or all 3. I've run into places that claim to be Tier 3, but that's for the Electrical only.

There are also varying levels of accreditation of datacenter. The highest, is having an actual auditor come out, and certifying the facility, (looking at the commissioning docs, examining the facility etc.). Most facilities will opt to not do this, as the audit usually costs a lot of money.

The next option is a certified design, where the datacenter sends off their plans to be reviewed, and receives approval on the design. However, this does not guarantee that the design was followed as implemented.

The last option is that the datacenter built to the Tier specification, but no one has audited the facility. This is usually the most common occurrence, where a vendor self reports what tier they think the building is.

Examples of Facilities that overstated their Tier

Here are some examples of self certified "Tier 3" facilities that overstated their tier:

- Fiber was not diverse in the building.
- "Diverse" fiber crossed in a manhole outside
- There was "1" generator
- Unable to maintain humidity.
- Not enough shipping docks.
- Concrete slab thickness was not thick enough.
- Doors were not tall enough to bring equipment in.
- Insufficient floor loading – I had a datacenter that had the correct floor loading on the datacenter floor, but had put down marble in the main pathway. It was not possible to bring equipment into the datacenter, without putting down Masonite (floor protection).

Full length Lift gate.

The reason for a full length liftgate, is for 2 purposes. Not every datacenter has a working loading dock. If they do, and have a dock leveler plate, you won't need a lift gate.

However, some DCs do not have a real loading dock, so you have to move a rack to the colo by bringing it off the truck using a liftgate.

Liftgates can be in varying size, but if you are bringing cabinets in, a full size liftgate (rated to ~4000 lbs. (2 tons) (double the weight of a cabinet) is a necessity.

This is a requirement, because we once had a delivery company show up with a ~2500 lb. half-size liftgate to deliver a 1600lb cabinet. When the cabinet was placed near the edge of the liftgate, in a crate, it fell off the edge of the truck, 4 feet into the road, and damaged a nearby car.

As a result, we were not able to use the capacity of the servers, and our integrator then had to file an insurance claim for the value of the rack.

Network Gear cooling.

Network gear has varying types of cooling. (eg: front to back, back to front, side to back, side to side etc.)

Ideally you want air pulled from the cold aisle to exit out the hot aisle.

While it is possible to cool equipment, in a cabinet that does not have correct airflow, it can be a pain. It usually involves mounting dedicated equipment that pulls air in from the front and exhausts out the side, or a complicated baffling system.

I have seen side to back equipment that registered 90C on linecards because it was in a poorly ventilated cabinet, without the correct cooling.

Individual server parts:

If you went with individual servers (as opposed to using an integrator), you have lots of potential issues, including:

- Limited access to the rack, (the cage walls are close in and you can't get more than 2 folks working on a cabinet at a time).

- you need more equipment than you think, (eg: power cables, network cables, in the right length and right color. Depending upon timelines, shortcuts may be made (using the wrong length cable etc.)).

- not everything will be labeled, or it may take longer to label everything.

- you may not have all of the parts on-hand, especially in the case of failure.

- the time to hand assemble and deliver a rack can be over four-man weeks! This is valuable employee time. The problem is even more pronounced if you are deploying in a remote city (costs for meals, hotel, and constantly changing airplane tickets due to pushed back deadlines etc.).

I once did a cage build at the same time as a company across the hall from me. I was fully live within 4 days. The other cage, was still not live weeks later.

Newer power requirements for linecards.

One of the great things about a chassis-based router, is that it can give you some future proofing. Buying a router today, where you can add more linecards down the line, or even the next generation of linecards.

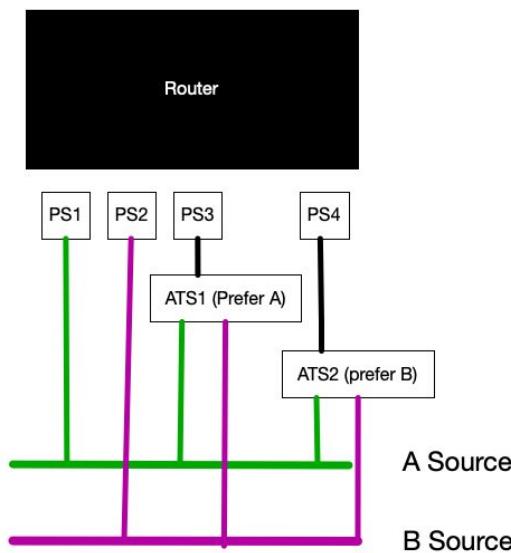
However, always keep in mind, that for your networking equipment you want at least 2N power. You want to be able to lose the entire A feed and keep running on the B feed.

This means, that if you have a 8 slot router, that has 4 power supplies, but needs 3 to keep all 8 linecards running, if you have a power failure of either feed, you will lose 2 power supplies, which will then result in losing linecards on your router, or losing your entire router.

There are ways around this; eg: by using ATSes, to allow for power to be drawn from various inputs, but the better long term strategy, is to make sure that you have the appropriate networking gear. When evaluating new cards, make sure to confirm the power draw as seen at the linecard, and see that you have enough headroom if you lost your A or B power feed.

Here is a picture of a sample topology that would make this work. This is not recommended, but worked as a stopgap.

“Router” Kludge - Redundant Power design



ATS=APC 1U Rackmount Static Switch
Note: C20-C13 cables needed for ATS

Clearly label any NON-RANGING power supplies.

Most gear these days is auto ranging from 100V – 240V.

However, some gear does not range well:

E.g.: Drill chargers, and stereo receivers only work at 110V (yes, I have had a stereo in a cage before)

Certain Networking equipment (eg: Arista 7508) also only works between 200-240V).

If the gear does not auto-range, please place a LARGE label on it, that clearly shows the voltage. (eg: like this picture):



With various adapters, and the need to test equipment in various places, it is possible for non-auto-ranging equipment to be plugged into the wrong voltage., and this will cause a breaker to trip, and take down the other connected devices!

Always specify the Outer diameter of thin copper cables.

When I neglected to do this, I received a cat6 cable, that was designed for 24AWG cable, but with 28AWG cables in the sleeve. There was no airflow/space advantage given by using the 28AWG cable, as it was still the original thickness of a 24AWG cable. Note: thin 28 AWG cables can be up to 4.7mm (.185 inches) thick.

If you are doing a special build of parts, make sure to see lots of samples first.

As in the above example, even if you think it's something simple (a cat 6 cable), things can go wrong. Make sure that you review all parts for workmanship and quality first.

Bulk fiber to the meet me rooms, instead of 1 crossconnect at a time.

If possible, you can prewire fiber to the MMR (Meet Me Rooms). Depending upon the panel, the cost, the labor, and your future growth, this should be done in 24 Strand increments.

This will allow you to have all your future crossconnects turned up, without someone working in your cage, for your cage to be a clean, well run area.

If your datacenter provider does 1 crossconnect at a time, they may be reticent to work on a live panel, and their ongoing quality may be poor.

Always file a ticket.

When you have an outage, you should ALWAYS file a ticket with the datacenter, even if it is after the fact. I once had a datacenter where the cooling failed, and my space went to over 90F. I went and told the techs, and they fixed the issue. I did not report an issue. Months later, the datacenter is showing that they have had months of continuous 100% uptime, (based upon there being no outage related tickets). Also, if you ever do want to apply for a credit, you need a electronic trail of what happened.

Always clean up your cage!

When you visit a cage, you want all of your parts to be nicely put away at the end of the day. That way you can find them when you need them next, if you do need remote hands to use tools, they will be easily accessible. If you keep it very clean, it will be a showcase area, and others will be inspired to keep their cage clean as well.

When the cage is not clean, you can have cases where the datacenter will clean it up for you, sometimes without notification, and throw away that very important item that you needed. I once had cleaned up a datacenter, and apparently, I didn't clean it up enough to the datacenters satisfaction, so they "cleaned" it up again, (and left 300K of Router blades on the ground.)

Also, when your infrastructure is a mess, datacenters can also deny remote hands work on your infrastructure, citing it as a hazard to work in there.

Questions for finance!

There are always edge cases, for finance. Try and solve some of these questions before they come up:

- If a \$250K rack is on a 3 year depreciation, but at year 2 gets ~\$50K of memory added to it, how does that affect depreciation? (is that now a 300K rack? Is the 50K added to the 3 year cycle? Do you have 2 depreciation cycles? How do you depreciate the extra memory, when the racks are removed at year 3? (Actual examples))
- If you add \$50K of memory to a \$250K rack, is the memory considered an asset (due to the value of the PO), how do you tag and trace it?

Hyper Growth, Delivery Cadence, and late night deliveries.

At one company, we had just opened our first datacenter and were taking a measured delivery of equipment. However, our site growth was faster than our projections and safety margin. We pushed our integrator to get a rack of servers faster than we had asked, and they were able to get it there around 5PM on a Friday. We needed to get the rack all the way to the datacenter floor, bolted down, powered

on, and configured before our peak on Saturday, or the site would not handle the load. However a few issues happened.

Normally the datacenter techs would deliver the rack to our cage, but they informed us (after the drivers had left), that they only had 1 tech for afterhours, and they could not move the rack to the cage, (as it had to go up a 40' ramp (to a 3' raised floor)). Thankfully I had a co-worker nearby, and he and his wife showed up, and helped me push the cabinet to the cage.

The datacenter was then able to bolt, and power the rack. The network was configured by ~9PM, and the systems were up on time! Heroics like this, while a good story, should be the exception, and not the rule.

Connectivity misdirection

I once did an install at a datacenter that said there were ~20 providers in the building. This was a true statement, but, this was a multi-story building, and the floor we were looking to go into, had 0 providers on the floor. This was only uncovered after we had signed. The vendor then told us that to get connectivity to the providers there would be a very large recurring fee. Specificity counts.

Modified gross and triple net comments

An issue I ran into with a Modified Gross Lease is that every cost is laid out for the life of the contract. This is normally a very good thing, but can also mean that any thing that is not specifically mentioned, can be a place to cut corners. Eg: If your contract does not specify 24x7 onsite security, onsite engineers, web portals, shipping, etc. then a landlord can remove these services as a way to maximize their profit from the contract. (I experienced this).

A triple net contract solves some of this, as all the tenants of the building pay a proportional cost of things like security, engineers etc. but there may be issues with that too, as costs may vary over time, etc.

APPENDICES:

Most of these point to external / online sheets or diagrams. Links are under each section, as well as explanations.

Common Sundries

Sample Project Plan

Sample rack layouts

Sample first colo questionnaire.

Colo - On-site visit evaluation

Integrator on-site visit evaluation.

Appendix A – Detail of Common Sundries

Dropbox link to excel sheet: File “**2021-cable-part-numbers.xlsx**”

<https://www.dropbox.com/s/il64dn9l93qetj1/2021-cable-part-numbers.xlsx?dl=0>

<https://github.com/cpc2018/my-first-colo/blob/main/2021-cable-part-numbers.xlsx>

Notes:

Not all of these parts may be specific to you. You may have different types of fiber cables, copper cables, a different color standard etc.

You may need more or less of certain parts depending upon your size of build, your sparing philosophy, or the amount of spare space in your cage.

With the current shortages, flexibility is required. Certify multiple parts, look for similar parts that may be in stock, etc.

Detailed discussion of each parts.

BLUE colored bin

RED colored bin

GRAY colored bin

60 small red bins

This is a free standing set of metal shelving with lots of small bins installed in it. This is a great way to put lots of really small items in a easy to find storage. (Optics, attenuators, short 28awg cables, short fiber cables, are all good candidates).

boxcutter

probably the most important item in a datacenter build. Buy multiple if you can, so that one is always in reach. Also, if you are working with an integrator who is doing pre-kitting, have this show up in an easily identifiable box (eg: a bright RED Box), and have it easily openable), so that it can be opened first. This is especially important if your staff will be flying in to assemble a POP.

tape measure

Needed to confirm that the cage is to your standards, as well as things like confirming that the racks are placed as indicated, the parts you ordered are the length indicated. If possible, order a tape measure that has imperial and metric, as different datacenters measure in different ways.

Earplugs

A datacenter can be a loud location. With the noise of the cooling infrastructure, your servers and routers, these can be very helpful. Other options include noise cancelling headphones (you can also listen to music)

pliers

Used for manipulation of various things. (eg removing stuck items)

Mallet

Needed to assemble various work carts.

wire cutters

Various uses, primarily cutting wire ties. Also, when you detect a bad cable, it is recommended to cut the end off, prior to throwing away, so that it can't be reused.

Screwdrivers

A variety of screwdrivers are really helpful for working in your facility. Also, off label uses (such as holding open doors) can be very useful.

3' stepladder

7' ladder

Ladders are key items in the datacenter. Usually you will need to do work withing your rack, fairly high up. You may also have to run cables between the racks, via an above rack cable tray.

Some datacenters may provide a ladder for you to use, but it is on a first come first served basis. When you need it, it may not be available. Some datacenters do not provide ladders either. Overall, it is best to get your own ladder.

long #3 drill bits

Drill

drill bits

200W 110V Adapter

C14 to C5 adapter

A drill is a key part of your datacenter build. Primarily this will be used as a electric screwdriver. The drill can be swapped with an impact driver as needed as well.

Most commonly you will be removing/installing equipment into the racks. This "should" require a #3 Phillips.

US Drill warning: The part listed is a US drill. If you are outside the US, consider buying a local edition. The US Drill is ONLY rated for 110V. It WILL NOT work in a PDU giving 200-240V without a 200-240V to 110V Adapter. The Adapter, and Adapter plugs, will allow for the drill to be charged while you are at the datacenter.

Cart

This is a portable 4 shelved work cart. This is a good all purpose cart that 2 people can work at. Also helpful for various storage. A mallet and phillips screwdriver are needed for assembly.

trash can

trash can wheels

This is a great way to put all your trash in one place, that is moveable easily to the dumpster / recycling (if applicable) Area.

NOTE: If your DC supports recycling, be sure to break your trash into the appropriate sections.

Make sure this is WELL Labelled, as the DC may take it, if it resembles theirs. Sometimes it makes sense to get a bin of a different (non standard color)

equipment lift

The equipment lift is a bit of an issue. It is a large device, intended for lifting servers and other equipment into place in a rack. As equipment that you rack can weigh hundreds of pounds, this is a good option. If your datacenter has one, then you shouldn't need to order this.

Note: This is not a perfect item, it is bulky, takes a large amount of space, and does not allow you to extend hardware into the rack. Also, all the work of lifting the equipment is manual. A better, but more expensive option, that is tailor made for this, is a serverlift, or a racklift.

Bin cabinet

If you have sufficient space, and lots of small parts, a bin cabinet may be of benefit. It can allow for up to 100 different small parts to be stored. With the use of the 60 small bin section from above, that may be a better choice, but this can be helpful in larger builds.

See-through cabinet

This is a great choice of a cabinet, that you can see into, to store parts. Depending upon the datacenter, this may also be a way to have cardboard in the datacenter, (usually not allowed).

back support

Key support item. This should be used when moving all large hardware. Have enough for each person moving hardware.

folding table

folding chair

Used to work in the datacenter when setting up.

Fiber cleaners

It is best practice to clean both sides of a fiber before connecting them. Even new from the factory, they are not clean. They are not assembled in a clean room.

Fiber testers - VFL

There are many different vendors who make fiber testing gear. The main items you will want are a Visual Fault Locator, which is used to trace a fiber and confirm where it goes. In a perfect world of every cable being labelled, this shouldnt

be needed, but this is a part needed due to operational reality.

Very helpful for confirming cabling into the Meet Me Room as well. (eg: you know the port goes to my cage, because of the “red light”)

Also, there are VFLs that are rated at > 40Km, which can be used for turning up various Dark Fiber links to other locations.

Fiber testers - Light Meter

The light meter is a great way to measure that the equipment you are plugging into is sending light and confirming what the actual light level is. Every optic has a transmit and receive threshold. The light meter will confirm that you are seeing the appropriate amount of light, and if you do encounter an issue should help you narrow down the problem (ie: I see the problem at the end of the cable, but not at the beginning, time to look in the middle).

Fiber testers - Light Source

When using the light meter, you need to measure against something that is sending light. Usually you should have the light being provided from a piece of live equipment. However, if that is not possible, using a dedicated light source, is a great solution.

Fiber testers - Magnifier.

The magnifier is used to take a close up look at the fiber connector to confirm that it is clean and able to pass data.

Please remember, that all fibers are not guaranteed to be clean when they come from the factory. You should be cleaning every fiber prior to insertion.

Unfortunately the magnifier usually only comes into play when multiple cleaning does not work / if you have a particularly dirty connector.

Fiber testers – SC to LC Adapter

Most fiber test equipment is still based around the larger, legacy SC connector. While the industry has mostly moved to the LC connector, test equipment is still predominantly SC. The LC Adapter will allow you to test your LC cables.

Fiber Attenuators – varying dB.

An attenuator is designed to attenuate (reduce) the fiber optic signal. This is usually used if you have too strong a signal coming into your equipment, to bring it into the specification. These are primarily used in DWDM type deployments, as usually within building optical connections are on 1-10Km optics that should not need attenuation.

Power cables – various short adapters.

These are for when you are on-site to plug in various devices into the rack. This is usually a labeler, or a laptop.

Power cables – varying lengths.

These are standard cables of varying length. Depending upon your build, you may have gear, and power strips that support C13,C14,C15,C19,C20,C21. The parts listed are various cables that allow connection to this.

Note: if you do not have some of these connectors in your equipment, you don't need to order them on day 1. But if you do start to order them, make sure you order spares!

A big thing to keep in mind, is the gauge wiring on your electrical cables. The thinner the gauge, the lower the power rating.

Power cables in servers, vary from 12 Awg, to 18Awg.

Also, keep in mind that power cables should have a temperature rating, and that the rear of the cabinet can reach up to 60C (or higher).

Part numbers listed in the appendix, are usually 14AWG 95C (or higher) (side note: the C13 connector is rated at 250V/10A outside of the US, and 250V/15A inside of the US (subject to location of manufacturer etc.). This also may not line up with the power rating of the PDU (eg: what it considers pulling too much power).

I've attached versions of power cables without built in locking ends, so that you can use a sleeve with them.

I've also, where possible, included power cables with dual locking ends. Make sure that these are all compatible with PDUs, and your equipment.

Power Cables - C19 Sleeve

Power Cables - C13 Sleeve

One of the common problems in a DC, is that occasionally cables can work themselves loose over time, leading to power supplies going down. There have been various ways to attempt to solve that:

Wire retention clips – a good solution, provided your power strip vendor supports them, you install them all, and they hold the cable well.

Power cables which lock into the power outlet – eg: by using a latch which attaches to the side of the outlet. Also a good solution, but may increase the per unit cost of each power cable by a few \$\$\$. Also, not every cable may be available in that color / connector

Sleeves – This is probably the cheapest way and involves attaching a sleeve between the power outlet and receptacle.

Any of the above solutions is viable. It is also recommended to make sure your cables are firmly seated when visiting your infrastructure. Also make sure you are getting power supply failure alarms.

Fiber Cables - varying lengths

These are standard cables of varying length.

Depending upon your build, you may have varying connectors, (LC, SC, MTP etc.) and various length needs. (0.5M – 100M).

Please make sure to use Single mode where appropriate and Multi Mode where appropriate. (do not use a SMF cable where MMF is needed and vice versa). If possible, use one standard type of cable (SMF), to reduce your sparing needs.

Bend insensitive is strongly recommended, as they are more forgiving than bend sensitive cables.

Make sure you have a spare of anything you are using in production. Also, remember that while it is possible, it is not recommended to use a significantly longer cable for a shorter run.

A warning on MPO/MTP – this is normally a good solution, but requires extensive understanding. An MTP 12, has 12 strands, MTP 24 has 24 strands etc.

There are 3 different wiring schemes for MTP: Method A,B,C.

Female cables, connect to male cables. Connectors are also keyed.

If you are doing a build, and trying to keep track of polarity, gender, breakouts etc. extreme care must be taken to ensure that your devices can connect to each other correctly.

A standard (in rack) run using 2 PLR4 optics would require: a Method B 3M Female to Female SMF cable.

Connecting these if they were racks apart would require A method B cable

a Method A 3M Female to Female SMF cable.

a Method A 20M Male to Male SMF cable.

a Method B 3M Female to Female SMF cable.

(note: Try to CLEARLY MARK all method A and method B cables, as this can be highly confusing. If you are using remote hands, this can be even more of a hassle).

(note: MTP also has breakout cables. If you are using this as a 40G (or 100G) to 10G breakout, make sure that there are 4 legs and they are in the format of : 1,12. 2,11. 3,10. 4,9 (and not 1-2, 3-4 etc).

Copper Cables – varying lengths

These are standard cables of varying length.

These are 1G rated Thin cat 6 cables, which are very helpful when working at the rear of the cabinet, as they are thin, and help airflow in the rack.

If you are looking to do 10G, make sure to order the appropriate cable. Keep in mind that may be thicker. You will probably not want a 10G cable for your onboard dedicated IPMI/OOB, as it is probably only 100mbit.

Optical Transceivers – varying types

Depending upon your networking vendor, you may be buying spares from them, or from a 3rd party. Some vendors support unlocked optics; either via selling unlock licenses, giving them away, or just out of the box. Sometimes, generic optics may need to be programmed to be compatible with the vendor.

Also, when you are bringing up circuits, make sure you know what you are connecting to on the other side, because you will need a matching one on your side.

This results in a lot of spares.

These also can go bad fairly frequently (but also can go bad because of dust/dirt, so make sure you clean and retest them before classifying it as bad).

Copper (DAC) and Optical (AOC) Cables/ varying types and lengths.

These allow you to connect devices to other devices using premade cables. For instance you can connect a switch to a host at 10G, using a DAC cable, or connect 4 hosts to a single switch port using 4 SFP ports to a single QSFP port.

This would allow you to have a great amount of density. (eg: this is how you could wire up ~80 hosts, into a 1U Switch).

These solutions are also usually significantly cheaper than having to have an optic on each side, and a cable in the middle. It is also, much less parts to fail and retest, to get a link back up.

The downside, is that when things go bad, you replace the cable, which can be more work in a rack, but it is something that is doable with remote hands (especially if its well labelled)

Rack Parts – Screws and Nuts

There are many different types of rack screws and nuts (10/32, 12/24, M5,M6, Clipsal connectors.

It is highly recommended to have 1 type of screw and nut throughout your infrastructure if possible. You also should have your own spares.

Frequently datacenters will put out a grab bag of mixed screws and nuts, but that can end up with your rack having 4 types of screws in it. Also, datacenters might not hand out screws/nuts, or can run out of screws/nuts. M6 is the current global recommendation.

Patch panels

When landing fiber in your enclosed cabinets, you will want to use a patch panel that allows you to add/remove infrastructure over time.

What I have found to work is a sliding patch panel, such as the Panduit FCE4U, that allows you to work on the front and rear of the panel, from the front of the rack. This allows you to have other equipment in the rack, and still be able to service it.

If possible, may sure to order bulk cables to the MMR where possible.

Patch panels – Splicing Trays.

When doing pre-laid cable to the MMR, they can be delivered either as cables needing to be fusion spliced, or as pre-terminated factory cables.

Depending upon your datacenter, and their relationship with fiber manufacturers, and local fiber installers, they may prefer pre-terminated or fusion spliced cables.

If possible, a pre-terminated should be preferred, as that would allow for quick turnup, once the racks are placed. With good co-ordination, a technician can fusion splice the cables efficiently as well in a reasonable time. (With poor co-ordination, you may end up leaving a site without your fiber spliced, or extending your trip)

At all costs, avoid having a panel with both fusion splicing and pre-made fiber, as they may be mutually exclusive.

Patch panels - Bulkheads / inserts

Depending upon your topology, you may need LC-LC, MTP-MTP, or MTP-LC panels. Here are some sample vendors, that are compatible with the patch panel.

Rack Parts - Wire managers and Brush panels.

Part of keeping a rack clean is the ability of dressing cables where possible, keeping them clean, and also moving cables from the front of the rack to the rear of the rack. Having wire managers, and brush panels, are good examples of this.

Note: Some gear has power connectors on the front of it. If all your power is delivered in the rear, it will have to make the transition to the front for the odd pieces of equipment. Examples include, Opengear 6248, and Arista 7504, and 7508. Pay extra care to larger C19/C20 connectors when feeding through brush panels.

Appendix B –Colo -Integrator on-site visit evaluation.

- File “**integrator-visit-checklist.xlsx**”

<https://www.dropbox.com/s/4owrw3wh923o5fs/integrator-visit-checklist.xlsx?dl=0>

<https://github.com/cpc2018/my-first-colo/blob/main/integrator-visit-checklist.xlsx>

Appendix C –Sample first colo RFP.

- File “**Generic-Datacenter-RFP-1.50-500kw.docx**
<https://www.dropbox.com/s/e8t5nk380eahgvp/Generic-Datacenter-RFP-v1.50-500kw.docx?dl=0>

<https://github.com/cpc2018/my-first-colo/blob/main/Generic-Datacenter-RFP-v1.50-500kw.docx>

Appendix D –Colo - On-site visit evaluation

- File “**colo-visit-checklist.xlsx**”

<https://www.dropbox.com/s/2wr7q44jd34m4yf/colo-visit-checklist.xlsx?dl=0>

<https://github.com/cpc2018/my-first-colo/blob/main/colo-visit-checklist.xlsx>

Before visiting the colo:

- Have good closed toe, (potentially steel toe) shoes that you can walk in, and don't mind getting dirty.
- Review the questionnaire responses, and generate questions
- Understand how much the site will cost over 3 years, and where it falls in relation to the other sites you will visit.
- Print out your on-site checklist, of what you want to see and bring it with you. (I usually paste it into an A5 notebook.)
- Bring a tape measure with you, just to confirm that your cabinets can fit.
- If possible, learn how to read a electrical and mechanical one-line. If not, bring someone with that background with you.

When visiting the colo for the first time, make sure to keep an eye out for a few things.

- How easy was it to get in. Were there gates at the property line. Is security in the building behind bullet proof glass.
- Confirm that the vendor fully understands your requirements, and has the space, power, floor loading, and carriers that you need within the building.
- That there are no issues with your panels, or your fiber density.
- How many generators were there at the facility. (there should be at least 2 or more).
- Walk / visually inspect the path from the street to the loading dock. Could a 55ft trailer get to the loading dock and deliver your equipment? Will you need a liftgate?
- Walk the path from the loading dock, to where your cage will be, and evaluate the clearances, to make sure that there is enough vertical and horizontal clearance to fit your rack. Confirm that the colo can handle your weight requirements, and that there are no steps etc.
- Visit both Meet me rooms. You want to see an example of workmanship and quality that the datacenter does.
- Confirm that the carriers you are looking for are in the meet me room, for the area you are going into.
- As you look at things like power outlets within cages, are they labelled neatly and documented?
- Is there a lot of mess? Is there cardboard everywhere?
- Look closely at the breakroom. Get a coffee. Make sure there is sugar and creamer. (Yes I've had Datacenters provide coffee, but no cups, or sugar).

- Is the electrical one line posted in all of the electrical rooms (and is it up to date)
- Is there a one line, in the NOC, and is it up to date. (I saw a DC that had just finished a major electrical upgrade, but the documentation was still 5 years old).
- Ask if they did a full Level 5 commissioning of the building, if they have the paperwork, and what were the results.
- Ask if you can see the maintenance schedule for the facility for the next 12 months (or until the end of the year).
- Confirm that there is an annual pull the plug test of the datacenter.
- Ask them what was the last SLA impacting outage that they had, what the issue was, how they resolved it, and how it won't happen again.

When leaving the colo.

- Finish writing down your notes,
- Score the datacenter.

Appendix E –Sample rack layouts

– File “[sample-rack-layouts.xlsx](#)”

<https://www.dropbox.com/s/0e5fwgku7bic8ls/sample-rack-layout.xlsx?dl=0>

<https://github.com/cpc2018/my-first-colo/blob/main/sample-rack-layout.xlsx>

This is a sample set of rack layouts.

There is an Excel version, which is probably the easiest versions to do.

Notes:

Demarc Rack: - if you are doing an in-wall / vendor provided demarc rack, it may make sense to forgo the demarc rack. However, if you do that, make sure you have room to add future DWDM gear, and a way to connect back to your network racks.

Network Racks: - There is a finite amount of rack space. Depending upon your total traffic, number of edge ports and ingress ports, you should be ok.

Server Racks: - Depending on what you need

a large number of physical servers (eg: up to 80 for compute),

A medium number of 1U servers (up to 40 for compute) / high end CPUs

a smaller amount of 2U servers (eg: GPU servers)

a very small amount of 4U servers (eg: lots of disk, or large GPU servers)

Make sure that your facility can keep up with the cooling and power delivery requirements.

Appendix F – Sample Project Plan

Now finished:

<https://github.com/cpc2018/my-first-colo/tree/main/project-plans>

Project plans - there are 4 types and 4 files types:

- Retail build - 1-25 racks, on a standard cadence
- Retail-build-fast - 1-25 racks, on an aggressive cadence
- Wholesale-build -25-200 racks, on a standard cadence
- Wholesale-build-fast -25-200 racks on an aggressive cadence

File types:

- oplx - omniplan file format
- csv - CSV layout (for easy importing to something) (eg: ms project)
- pdf - a pdf of the tasks and days needed
- gantt.pdf - a pdf of the tasks and gantt chart

Some of these time frames can be condensed (especially if you have vendor relationships, and ARIN IP/IPv6 space etc.)

The End?

Thanks!

--Colin

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