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Evaluating Customer Energy Invoice Calculation as a Service

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Open your mind. LUT.
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Introduction

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- Finnish Government act (2009) on installing remote readable energy meters to 80% of households by the end of 2013
- Smart Grids and Energy Markets (SGEM) project in Finland
- Using cloud computing as part of the smart grid infrastructure
  - Case: Customer energy invoice calculation as a service

Smart Grids – what are they?

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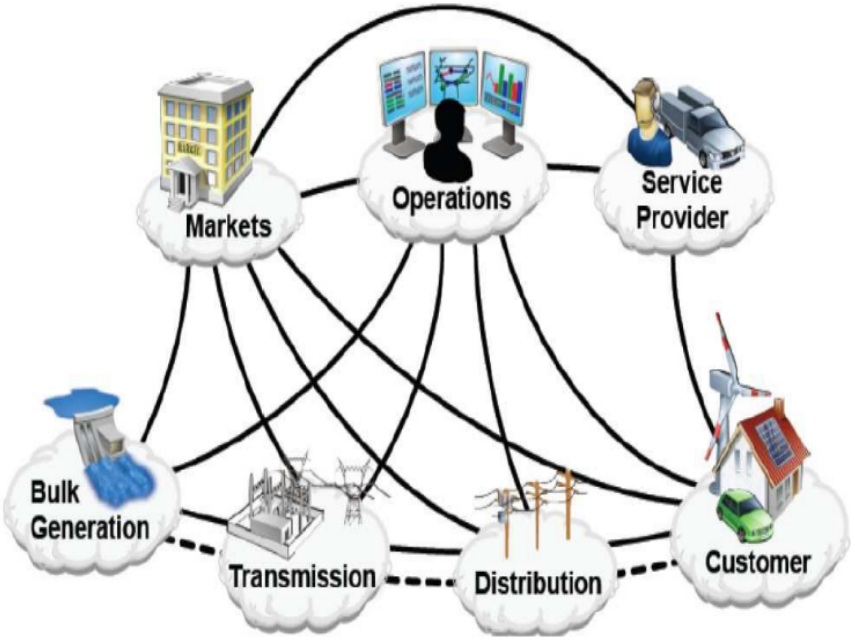
- The next step of electricity networks
- Allows two-way flow of electricity between all the involved parties
- Both automated & Distributed electricity
- Allows consumers to provide energy to the network as well



Picture from: J. Popeanga, "Cloud Computing and Smart Grids," *Database Systems Journal,* vol. 3, no. 3, pp. 57-66, 2012.

sgem
Smart Grids and Energy Markets

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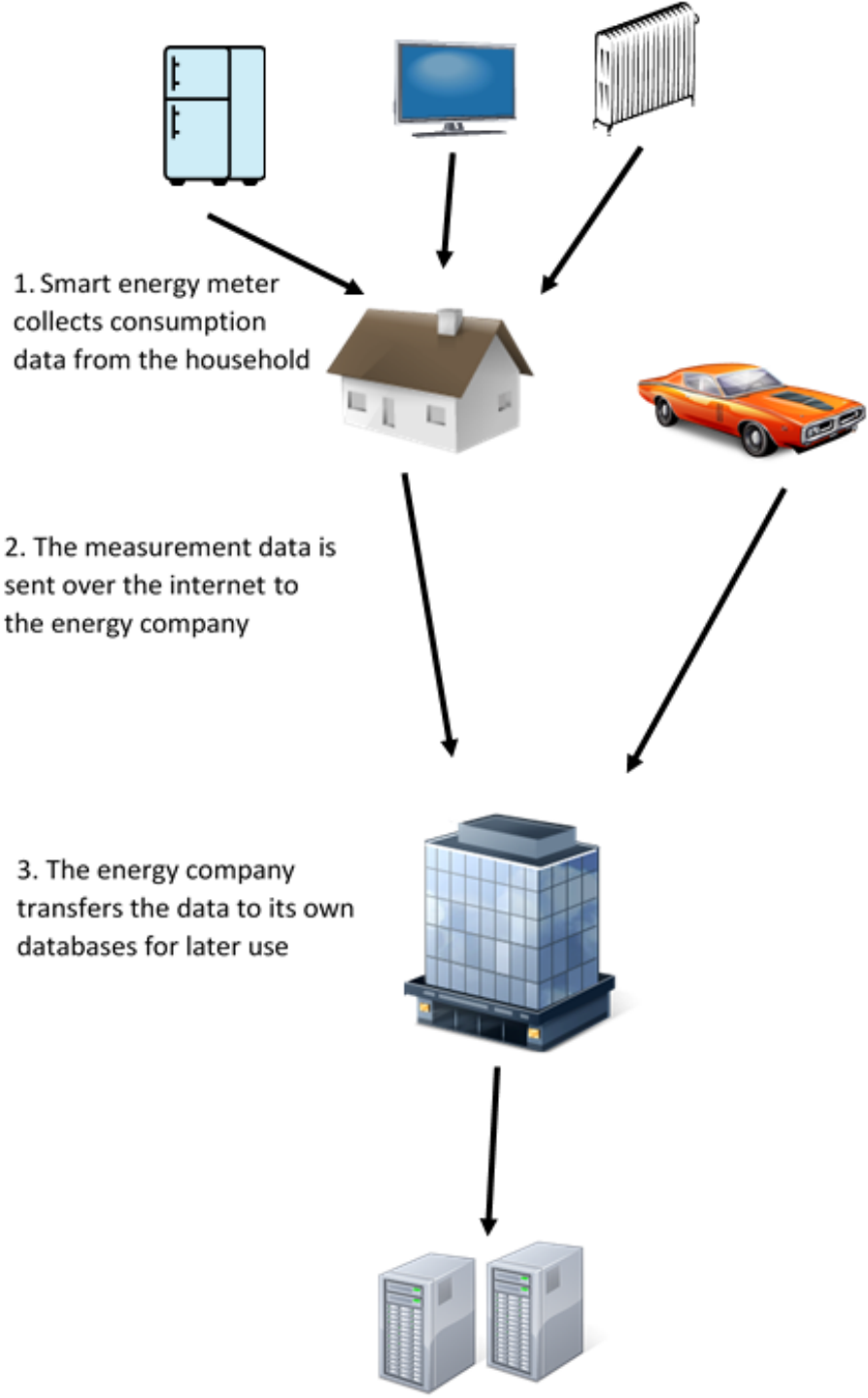
- The aim of the **Smart Grids and Energy Markets (SGEM)** research program is to develop international smart grid solutions that can be demonstrated in a real environment utilizing Finnish R&D infrastructure. At the same time, the benefits of an interactive international research environment will accumulate the know-how of world-leading ICT and smart grid providers.
- **The main components of the research are:**
  - Smart grid architectures and distribution infrastructure
  - Intelligent management and operation
  - Active resources
  - Market integration and new business models

Smart Meters

- Smart meters are the ”backbone” of smart energy grids
- Installed at households, monitor the flow of energy



Case: Energy Invoice Calculation in the Cloud

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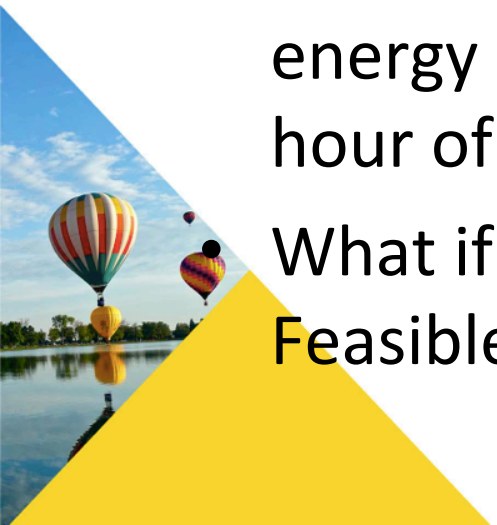
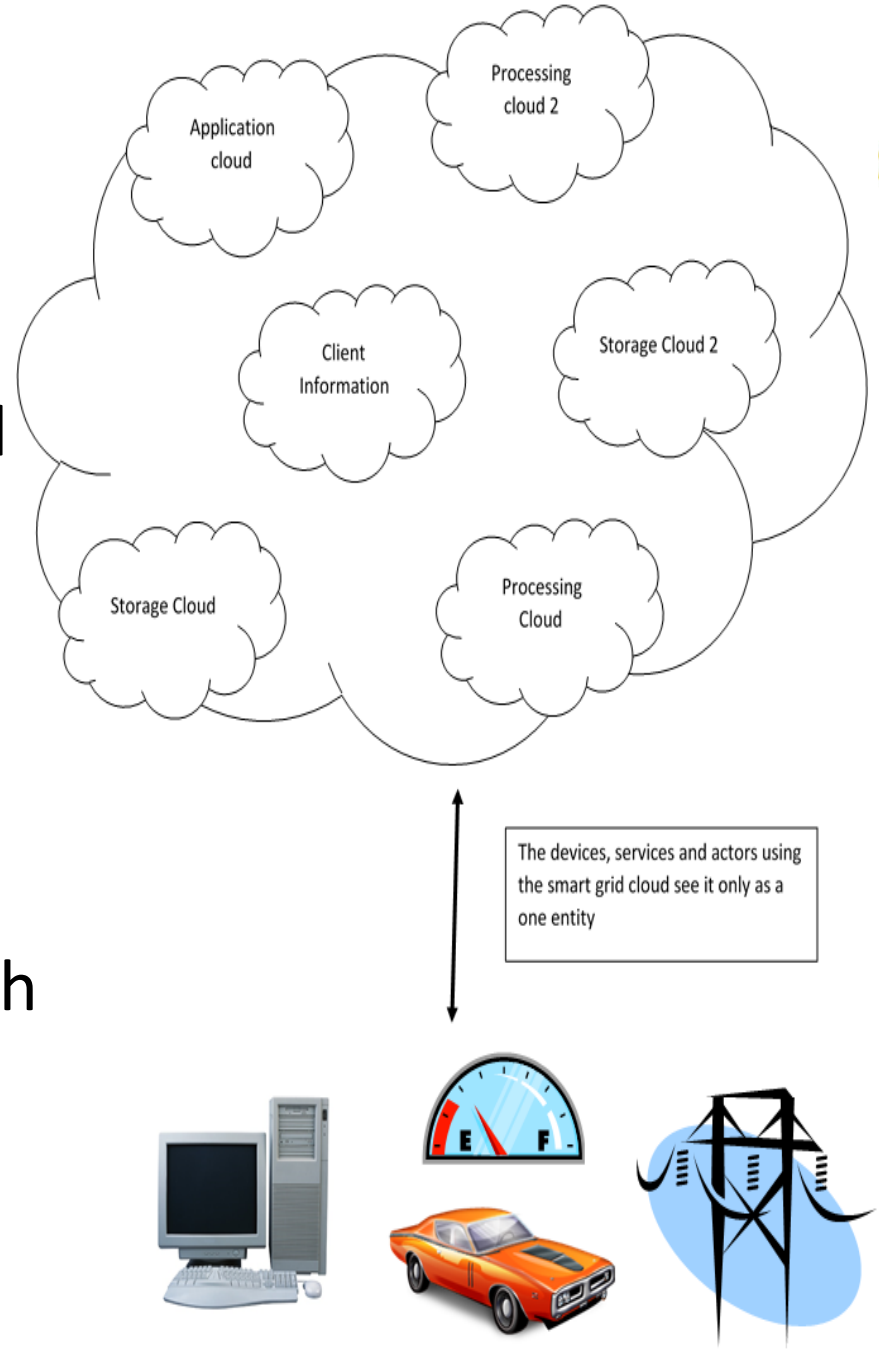
- Customer energy consumption (and production) data is measured by the smart meters
- Meters create huge amounts of data, as consumption can be tracked even on a minute-by-minute basis
- Matching current energy consumption to the actual energy price on the fluctuating markets, for every hour of every client with different contracts
- What if this would be done in the cloud? Possible? Feasible? Costs?



Our Vision:

- ”One community cloud that contains multiple private and public clouds.
- Multiple different application, processing and storage clouds each with their own specific tasks”



Issues of Cloud Computing

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- Privacy, Security, (Legislations)
- Service Availability
  - Cloud provider blackouts?
- Cloud provider policy stability?
  - Risk of being locked to one provider
  - What if they decide to change terms or prices?

Comparing Amazon & Microsoft

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Cloud Service	CPU Cores	Memory	Disk Space	I/O Perf	Cost / Hour
Amazon Micro	Shared	613 Mb	None (EBS storage only)	Low	$0.0035
Azure Extra Small	Shared	768 MB	20 GB	Low	$0.02
Amazon Small	1	1.7 Gb	160 Gb	Moderate	$0.091
Azure Small	1	1.75 GB	225 GB	Moderate	$0.09
Amazon Medium	2	3.75 Gb	410 Gb	Moderate	$0.182
Azure Medium	2	3.5 GB	490 GB	High	$0.18
Amazon Large	4	7.5 Gb	2 x 420 Gb	High	$0.364
Azure Large	4	7 GB	1,000 GB	High	$0.36
Amazon Extra Large	8	15 Gb	4 x 420 Gb	High	$0.728
Azure Extra Large	8	14 GB	2,040 GB	High	$0.72

- Similar pricing, similar processing capabilities
  - The pricing has moved to match competition, used to be different

Storage and Data

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- Basic cloud service focuses on computation
- Need to consider also communication and storage space
  - Communication costs around 100€ / TB (outgoing traffic)
  - Storage space from 50 to 100€ / TB
- Neither communication or storage are a limiting factor

Meter Information

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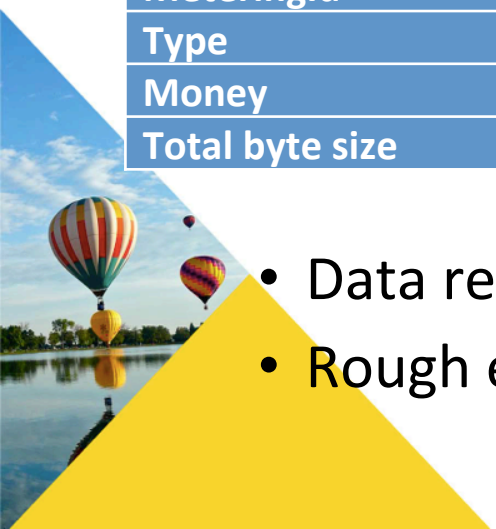
Parameter	Explanation	Parameter Type	Example value	Size (in bytes)
StartDate	The start time of the meter reading	DateTime	15.1.2012 12:00	8
EndDate	The end time of the meter reading	DateTime	30.8.2012 7:59	8
Value	The value	Decimal	803 547	16
Unit	The unity type of the value	String	kWh	3
Status	Status of the reading (OK, missing, estimate)	String	Ok	2
MeteringId	The ID of the meter	Int32	1	4
Type	Type of the measurement	String	TimeFrame	9
Money	The cost	Decimal	55 874	16
Total byte size				**66**



- Data received from smart meters, type and byte size (in C#)
- Rough estimates, more complex in reality (and larger in size)

Data transfer in reality

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- Transferring already from meters to company database
- Tranferring again from company to cloud makes no sense?
- -> Store to cloud, less transfer and information always available

	300 000 customers	500 000 customers	1 000 000 customers
15 min timeframes	57.024 Gb	95.04 Gb	**190.08 Gb**
60 min timeframes	14.256 Gb	23.76 Gb	47.52 Gb

	1 Mbit/s	2 Mbit/s	5 Mbit/s	10 Mbit/s
47 520 Mb	4,40 days	2,20 days	0,88 days	0,44 days
190 080 Mb	17,60 days	8,80 days	3,52 days	1,76 days

Evaluating cloud

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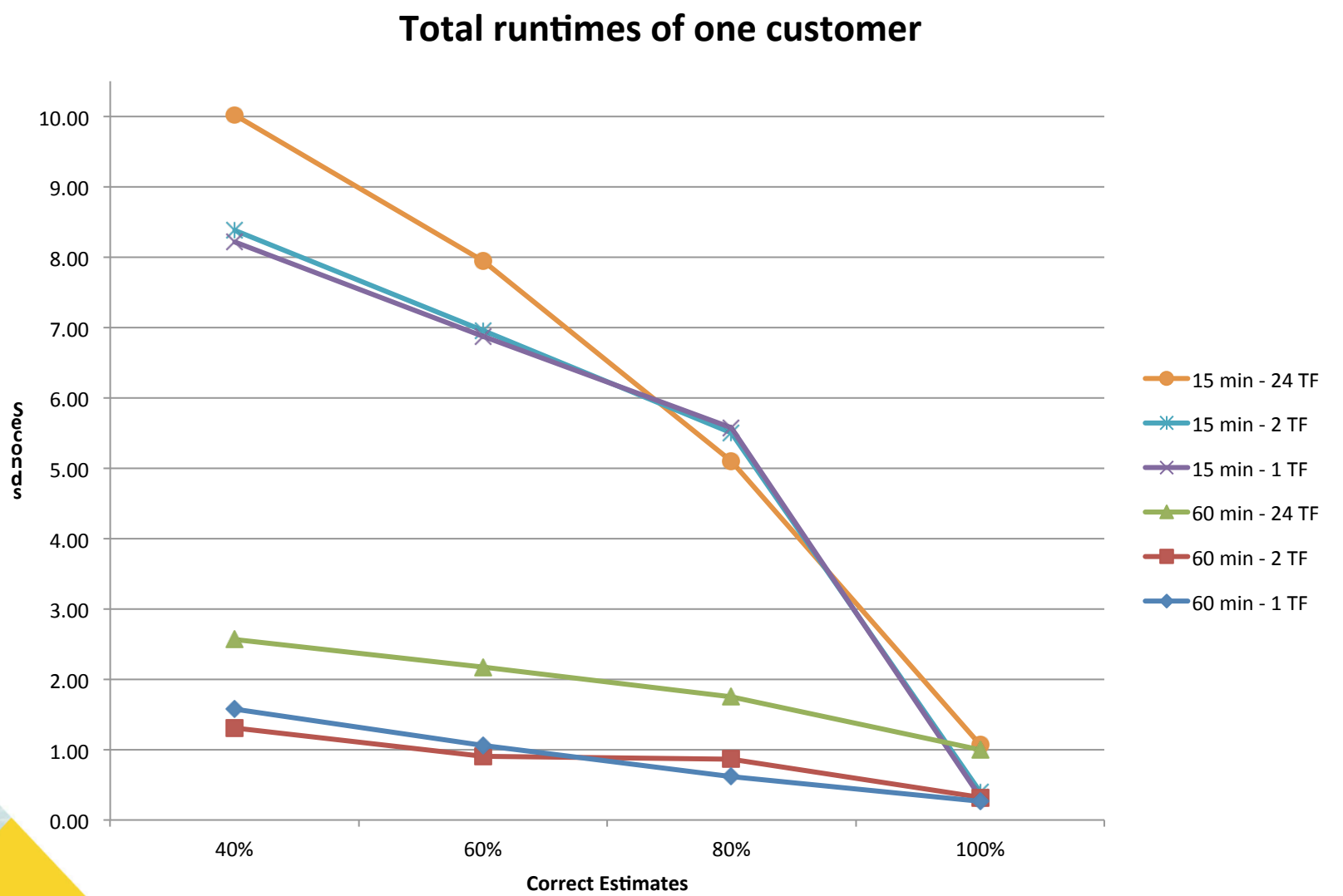
Parameter	Values
Measurement interval	15 min, 60 min
Price interval	1/day, 2/day, 24/day
Correct estimate percentage	40%, 60%, 80%, 100%
Number of processor cores	1, 4
Number of clients	1, 100 000, 1 000 000

- Evaluated performance of calculation with different parameters
  - Sequential vs. Parallel
  - Calculating a batch vs smaller pieces

Evaluating variable impact on calculation



- Smart meter reading correctness has the most impact
  - Less recalculation -> faster

Invoice Calculation - comparison

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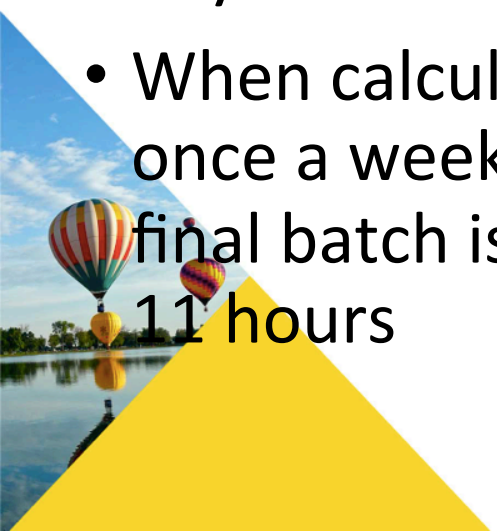
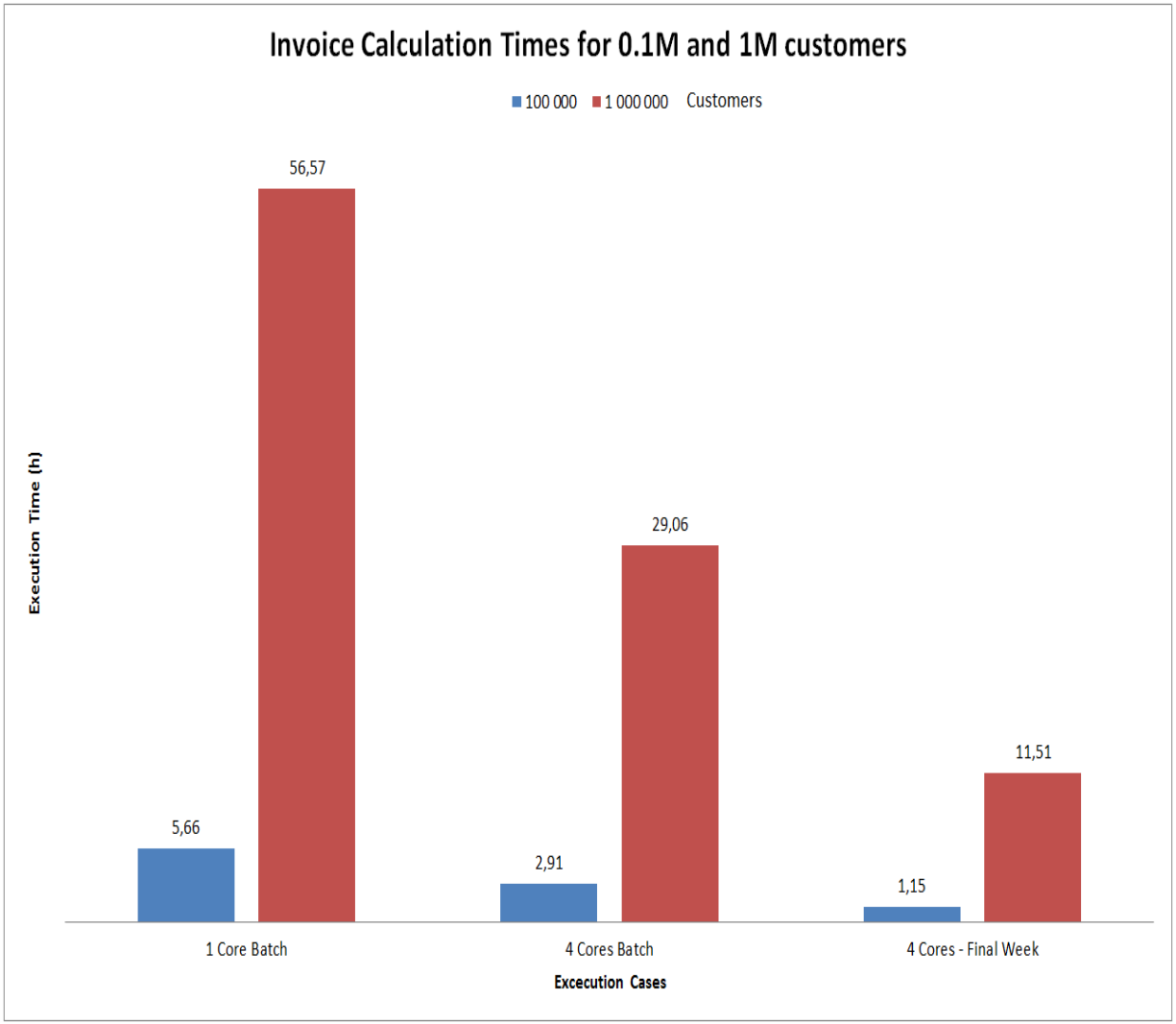
- Batch processing sequentially takes over 2 days
- Parallel computation drops to a mere day
- When calculated once a week, the final batch is only 11 hours





Cost of of calculation

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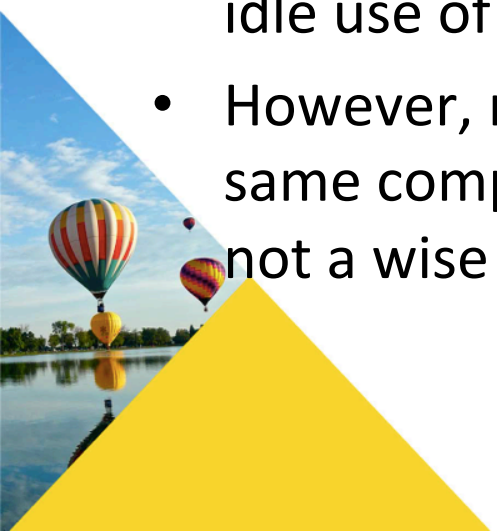
- Calculating in the cloud on-demand is quite cheap process
- However, requires that all data resides close (inside the same cloud or datacenter) to prevent idle use of resources
- However, running the same computer 24/7 is not a wise option

	4 Cores batch	4 Cores – Final Week
Microsoft Azure	$10,4616	$4,1436
Amazon AWS	$10,5778	$4,1896

	4 Core 24/7
Microsoft Azure	$262.08
Amazon AWS	$292.2



Conclusion

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- Cloud services are scalable
- Cheap in terms of money, if real on-demand could be used
- Requires: Large community cloud with all the data accessible to different parties when required
  - Store all data to cloud -> only transfer data once to cloud, then use it inside
  - Processing jobs can be run on-demand
  - Scaling on-demand
- Privacy? Security? Provider lockdown? Service Level Quality? Companies own policies?