INTELCAN

SKYCONTROL ATM in Air Traffic Management

Company Overview

SkyControl ATM is the flagship air traffic management system developed by **Intelcan Technosystems Inc.**, a Canadian company specializing in CNS/ATM solutions and airport infrastructure. Intelcan was founded in 1973 and is headquartered in Ottawa, with a global footprint delivering solutions in over 60 countries (Intelcan - a ATC Company on ATC Network) (Intelcan - a ATC Company on ATC Network). The company provides end-to-end aviation systems – from navigation aids and communication systems to the design and construction of control towers – often integrating its own **"Sky" series** products into complete, cost-effective solutions for clients worldwide (Intelcan - a ATC Company on ATC Network). SkyControl ATM forms a core part of this product suite, representing Intelcan's primary offering in en-route and terminal air traffic management systems.

As a modern ATM solution, SkyControl ATM plays a key role in **flight management and air traffic management** for Intelcan's clients. It is designed to cover the full spectrum of ATC operations, from oceanic and en-route control down to approach and tower control (Oracle Telecomputing Inc. is now wholly owned by Intelcan). Intelcan emphasizes that deploying SkyControl ATM as a single integrated system for all control environments helps simplify training and maintenance, offering a **cost-effective** alternative to multiple specialized systems (Intelcan's Skycontrol ATM commissioned in Sri Lanka). Over decades, Intelcan has established itself as both an integrator and manufacturer, ensuring SkyControl ATM meets rigorous international standards (ICAO, EUROCONTROL, and even NATO requirements) while remaining adaptable to the needs of different regions and airspace domains (Slide 1).

SkyControl ATM System: Technologies and Services

SkyControl ATM is a state-of-the-art software and hardware suite for managing air traffic across all flight information regions and phases of flight. Architecturally, it is a configurable **Linux-based system running on COTS hardware** with built-in redundancy (hot/standby servers and dual networks) to ensure high availability. The system includes both a Sensor Data Processing System (SDPS) and a Flight Data Processing System (FDPS), integrated via controller workstations that provide an optimized human-machine interface for air traffic controllers (Products – Intelcan). SkyControl ATM adheres to ISO 9001 quality processes and international ATM standards, meaning it can interface with other compliant systems and be deployed in civil or military ATC environments without custom development (Slide 1).

Key **technologies and capabilities** of SkyControl ATM include:

- **Multi-Sensor Surveillance & Tracking:** Ingests and fuses data from numerous surveillance sources – primary and secondary radars, ADS-B (automatic dependent surveillance – broadcast), MLAT, **ADS-C** (contract) data via CPDLC, as well as synthetic (flight plan) tracks – into a single consolidated air picture (Intelcan Preparing ATM Tracker for DGCA Indonesia – Intelcan) (Intelcan's Skycontrol ATM commissioned in Sri Lanka). The system's tracker can handle diverse sensor inputs (even legacy radars) and output standardized tracks (e.g. Eurocontrol ASTERIX format) for display or downstream systems (Intelcan Preparing ATM Tracker for DGCA Indonesia – Intelcan) (Intelcan Preparing ATM Tracker for DGCA Indonesia – Intelcan).
- **Flight Data Processing & Automation:** Provides a fully automated flight plan processing system that handles flight plan inputs, updates, and distributes relevant information to controllers. It supports electronic flight strips and processes standard ATS messages (ICAO FPL, OLDI, AIDC, etc.), assisting with **coordination between sectors/centers** and reducing manual workload (Products – Intelcan). A built-in **air traffic trajectory model** and conflict probe tools allow the system to predict potential conflicts and suggest resolutions in advance (Products – Intelcan).
- **Safety Nets and Alerts:** Includes advanced safety net functions to enhance flight safety. Controllers are automatically alerted to conflicts or hazards via features like **Short-Term Conflict Alert (STCA)** for imminent separation conflicts, **Minimum Safe Altitude Warning (MSAW)** for terrain clearance, as well as area intrusion alarms for restricted or dangerous airspace (SKYCONTROL (ATM) - INTELCAN - PDF Catalogs | Technical Documentation | Brochure). These safety nets help controllers take preventive action and are configurable to the airspace's requirements.
- **Data Link and Messaging Integration:** Natively supports air-ground data link communications such as **Controller–Pilot Data Link Communications (CPDLC)** and ADS-C, enabling reduced voice congestion and long-range oceanic control capabilities (Intelcan's Skycontrol ATM commissioned in Sri Lanka). It also interfaces with ground-ground messaging systems (**AFTN/AMHS** for flight plans, NOTAMs, etc.), ensuring seamless information flow between the ATM system and other aviation facilities (Intelcan's Skycontrol ATM commissioned in Sri Lanka).
- **Scalable Workstation Interface:** The controller working positions are highly configurable, with the ability to display multiple customized maps, weather data, flight lists (arrival, departure, overflight), and to filter or color-code targets as needed (Products – Intelcan). Despite its extensive features, the interface is kept **minimalistic and user-friendly**, focusing on the essential information to optimize controller workload (Products – Intelcan). Each controller can tailor the display (symbols, labels, units) and those preferences persist between sessions (SKYCONTROL (ATM) - INTELCAN - PDF Catalogs | Technical Documentation | Brochure).

- **Training Simulator and Tools:** SkyControl ATM is complemented by a full **simulation mode** that can be used for controller training or as an emergency fallback system (Products – Intelcan). This simulator can generate traffic scenarios and playback recorded data, allowing air navigation service providers (ANSPs) to train staff and test procedures without impacting live operations. Additionally, the system offers maintenance and analysis tools (e.g. recording and replay of radar data and communications) to support post-incident analysis and system monitoring (Intelcan's Skycontrol ATM commissioned in Sri Lanka) (SKYCONTROL (ATM) - INTELCAN - PDF Catalogs | Technical Documentation | Brochure).

Beyond the technology itself, Intelcan provides a range of **services around SkyControl ATM**. Projects typically include system design, integration with existing infrastructure, installation and calibration of equipment, and comprehensive training for controllers and technical personnel (CADSUR Contracts Intelcan to Modernize its Air Navigation Infrastructure – Intelcan). Intelcan also offers ongoing maintenance support and technical assistance to ensure the ATM system continues to operate to specification. In many cases, SkyControl ATM is delivered as part of a **turnkey solution** – for example, alongside Intelcan's navigation aids (ILS/DME), surveillance sensors (radars, ADS-B stations), voice communication systems, and even construction of new ATC facilities – giving clients a one-stop solution for modernizing their air traffic management infrastructure (CADSUR Contracts Intelcan to Modernize its Air Navigation Infrastructure – Intelcan). This integration capability has been a selling point for the company, as it can tailor a complete package that meets ICAO standards for a given region's CNS/ATM modernization plan (CADSUR Contracts Intelcan to Modernize its Air Navigation Infrastructure – Intelcan).

Recent Innovations and Developments

Intelcan continuously updates SkyControl ATM to incorporate new technologies and to meet evolving industry requirements. In recent years, a notable focus has been on integrating next-generation surveillance sources and improving interoperability. For instance, **space-based ADS-B** capability has been added to SkyControl's surveillance inputs. In a 2023 project with the Agency for Aerial Navigation Safety in Africa (ASECNA) covering Equatorial Guinea, Intelcan provided **satellite ADS-B** data integration alongside ground ADS-B stations, coupled with upgrades to the SkyControl ATM system to utilize those new surveillance feeds (Intelcan is proud to announce our project with ASECNA in Equatorial Guinea... | Intelcan Technosystems Inc.). This enhancement allows controllers to receive real-time aircraft position reports even over remote oceanic or jungle areas via satellites, significantly improving surveillance coverage and flight tracking in that airspace. Such developments show SkyControl's adaptability to cutting-edge surveillance innovations (in this case, leveraging orbiting ADS-B data services) to enhance flight monitoring and management.

Another recent development has been the modular deployment of SkyControl ATM components. In 2020, Intelcan delivered the **SkyControl "Tracker" subsystem** as a standalone product to Indonesia's Directorate General of Civil Aviation (Intelcan Preparing

ATM Tracker for DGCA Indonesia – Intelcan). This tracker module takes in a "multitude of radar sensors" from different manufacturers – including older legacy radars – and fuses the inputs into a single standardized output (Eurocontrol ASTERIX Category 62 format) for use by Indonesia's national ATC system (Intelcan Preparing ATM Tracker for DGCA Indonesia – Intelcan). By deploying the tracker on its own, Indonesia could upgrade its surveillance data processing without replacing the entire ATM system. *"The technical challenge resides in the variety of inputs we have to process, validate, and from which the system has to extract valuable data. We're not only dealing with different sensor manufacturers but also with legacy ones,"* explained Brian McGregor, an ATM architect at Intelcan, regarding this project (Intelcan Preparing ATM Tracker for DGCA Indonesia – Intelcan). The success of the Indonesian deployment demonstrated SkyControl's flexibility in heterogeneous environments and Intelcan's capability to solve complex integration problems – an important innovation for countries looking to incrementally modernize their ATM infrastructure.

Intelcan also engages in continuous improvement of SkyControl's software. Upgrades are made to comply with new ICAO procedural changes and to enhance cybersecurity and system resilience as needed (for example, ensuring compatibility with the latest **Flight Plan format changes** or implementing new safety nets mandated by regulators). The **user interface** and human factors design are periodically refined with controller feedback to maintain an optimal workload and situational awareness. While these software-centric innovations are incremental and often behind the scenes, they are crucial for keeping SkyControl ATM current. The company's acquisition of **Oracle Telecomputing Inc. (OTI)** back in 2013 laid the groundwork for many of these software advances – OTI was a leading supplier of ATM and simulation systems, and its technology was fully integrated into SkyControl ATM to provide a robust common platform (Oracle Telecomputing Inc. is now wholly owned by Intelcan) (Oracle Telecomputing Inc. is now wholly owned by Intelcan). This has enabled features like high-fidelity ATC simulation and advanced flight billing interfaces to be part of Intelcan's offering. Overall, through both internal R&D and strategic projects, SkyControl ATM has evolved into a **modern, network-centric ATM system** that embraces new surveillance modalities, data link integration, and user-oriented enhancements to meet the demands of contemporary air traffic management.

Clients, Partnerships, and Regions of Operation

One of SkyControl ATM's strengths is its **global track record** – the system has been deployed on **all five continents**, serving a wide variety of airspaces and clients (Slide 1). Many national civil aviation authorities and air navigation service providers have chosen SkyControl as their primary ATM system, especially in emerging or medium-sized markets. In **Asia**, for example, **Sri Lanka** upgraded to SkyControl ATM at its Colombo Area Control Centre, replacing an older system to enhance en-route and approach control for the island nation (Intelcan's Skycontrol ATM commissioned in Sri Lanka). **Taiwan** and **South Korea** have also been cited among the system's users. In the **Middle East**, **Oman** has deployed SkyControl, reflecting Intelcan's reach into Gulf states. Across **Africa**, several countries' FIRs are managed with SkyControl – notably through collaborations with **ASECNA**, which has led to installations in states like Equatorial Guinea, Algeria, Liberia, Mozambique, and others. Latin America and the Caribbean make up another important market: nations such as Cuba, Brazil, Suriname, and Guyana have implemented SkyControl ATM as part of modernizing their air traffic management infrastructure. In fact, Intelcan's comprehensive CNS/ATM modernization project in Suriname (completed in 2019) included SkyControl ATM along with new radars and communications, delivered as a turnkey package for the country's FIR (CADSUR Contracts Intelcan to Modernize its Air Navigation Infrastructure – Intelcan).

In Europe and North America, SkyControl ATM has seen more specialized use. Bulgaria's civil aviation authority is listed among the clients, and Intelcan has also supplied systems to Canada (its home country) and even the United States. In the U.S. context, Intelcan's technology was selected as part of a partnership with ITT Exelis (now Harris Corporation), where SkyControl ATM was used to complement Harris's surveillance offerings for certain defense and military air traffic management needs (Slide 1). Through this partnership, Canada's Department of National Defence and Sweden's Ministry of Defense deployed SkyControl elements for air surveillance/management in military contexts (Slide 1). This is possible because the system meets NATO and military-grade requirements in addition to civil standards (Slide 1). Such collaborations indicate that, despite Intelcan's smaller size relative to giant defense contractors, its SkyControl ATM is trusted enough to be integrated into solutions for demanding clients like national defense organizations.

To support its widespread deployments, Intelcan maintains regional offices or representatives in places like South Africa, France, Spain, Korea, Cyprus, Bulgaria, and Cuba, in addition to its R&D center in Montreal (Intelcan - a ATC Company on ATC Network). These outposts help the company provide local support and cultivate partnerships. For instance, working closely with ASECNA in Africa and with domestic industry partners in places like the Middle East has been key to Intelcan's project success. On the industry side, Intelcan often partners with other aviation technology firms when delivering a complete system – for example, integrating a third-party Voice Communication System (VCS) or surveillance sensor as part of an ATM project. In Sri Lanka's case, SkyControl ATM was interfaced with the SITA Aircom network for data link services (Intelcan's Skycontrol ATM commissioned in Sri Lanka), illustrating how Intelcan collaborates with communications providers. This flexibility in partnership and integration allows SkyControl ATM to fit into a country's broader aviation ecosystem, working alongside existing services (communications networks, weather systems, etc.) as needed. Ultimately, Intelcan's client list and global operations underscore that **SkyControl ATM is a proven solution in diverse operational environments**, from island nations and remote regions to continental airspace and even military air defense sectors.

Market Position and Competitors

In the worldwide air traffic management technology market, SkyControl ATM and Intelcan occupy a niche as a **mid-sized, specialized provider**. The market is largely dominated by a few major aerospace/defense firms – for example, Thales (with its TopSky ATC system), Indra, Raytheon Technologies, Leonardo, and L3Harris, among others, supply ATM systems to the world's largest ANSPs and airspace programs. Compared to these giants, Intelcan is smaller, but it competes by offering **highly customizable and comprehensive solutions at a lower total cost**. Intelcan explicitly markets SkyControl as "one of the most cost-effective solutions in the market" for ATM (Intelcan's Skycontrol ATM commissioned in Sri Lanka). This value proposition has resonated especially with developing countries and budget-conscious authorities that need modern capabilities without the price tag of the top-tier vendors.

SkyControl ATM's ability to cover all control environments (tower, approach, en-route, oceanic) with one integrated system is a competitive advantage, simplifying the technology footprint for an ANSP (Intelcan's Skycontrol ATM commissioned in Sri Lanka). Many competitors offer separate products or modules for tower versus en-route operations, whereas Intelcan's unified approach can be more efficient for smaller nations. Additionally, Intelcan's willingness to **tailor solutions and provide turnkey services** (including infrastructure building and long-term support) sets it apart from some competitors that primarily sell off-the-shelf systems. Clients in over 60 countries have demonstrated confidence in Intelcan's offerings, validating its market position despite not being the largest player (Intelcan - a ATC Company on ATC Network). The company's strategic partnerships also enhance its credibility – being **selected by ITT Exelis/Harris** to complement their surveillance solutions in U.S. and international projects is a testament to SkyControl's technical strength and reliability (Slide 1).

It's worth noting that the ATM industry is evolving, with trends like remote/digital towers, system-wide information management (SWIM), and increased automation/AI. Intelcan, through SkyControl ATM, is keeping pace by ensuring compliance with new standards and integrating new data sources as they emerge (as seen with ADS-B and data link integration). While it may not have the same research budget as larger competitors, Intelcan leverages its agility and focused expertise to adapt quickly to customer needs. In summary, **SkyControl ATM holds a solid position as a flexible and proven ATM system** for a segment of the market that values cost-effectiveness and customization. Its presence on all continents and its use by both civil and military clients demonstrate that it can successfully compete with the big names in air traffic management technology (Slide 1) (Intelcan's Skycontrol ATM commissioned in Sri Lanka). The system's track record and continuous improvements suggest that SkyControl ATM will remain a relevant option for ANSPs seeking a balance of performance and affordability in managing flight operations and air traffic.

Sources: Official Intelcan product literature and press releases, industry news from ATC Network, and ICAO/industry presentations were used to compile the above information. Citations are included inline to reference specific details.

Below is a practical "road-map" you can follow to make your profile line up with SkyControl ATM's day-to-day workflow at **Intelcan Technosystems**.
I've grouped it in two parts:

1. **What they actually work on (so you can target the right skills)**

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1 | What the SkyControl R-&-D team touches every day

Area	Typical Stack / Tools	Why it matters for SkyControl
Core OS	Enterprise-grade Linux distribution (often Red Hat/CentOS 7 → Alma/Rocky 8, sometimes Ubuntu LTS) running on COTS servers with realtime tweaks (`PREEMPT_RT`)	SkyControl ATM itself is *architecturally configurable Linux-based* software deployed on redundant servers and operator workstations ([[PDF] SKYCONTROL ATM
Languages	C & C++17/20, a little POSIX C for low-level I/O, Qt 5/6 for the controller HMI, Python/Bash for build & test scripts	The radar/flight-data processes are latency-sensitive C/C++ daemons; the GUI is a Qt thin client
Build / CI	`gcc` / `clang` , `cmake` , Jenkins or GitLab-CI, Conan for C++ dependencies	Continuous integration validates every commit against safety-net regression tests
Networking & Protocols	UDP/TCP multicast, shared memory, IPC, NTP/PTP time sync; aviation formats: ASTERIX Cat 34/48, OLDI/AIDC, CPDLC messages	Servers ingest radar & ADS-B feeds, then push fused tracks to workstations in real time
System services & HA	`systemd` , HAProxy, Pacemaker/Corosync or keepalived for hot/stand-by servers, RAID / MD, dual NIC bonding	24/7 availability is mandatory in ATM – controller can hot-switch to the backup node
Debug & Perf	`gdb` , `valgrind` , `perf` , `tcpdump` , Wireshark + ASTRIX dissectors	Used daily for field issue triage and latency budgeting
Security / Hardening	SELinux (targeted policy), iptables/nftables, auditd, CIS-level hardening scripts	Civil & military ANSPs require evidence of secure-by-design systems

You'll also see tools like Git, Jira, DOORS (requirements), and Clang-Tidy / Coverity for static analysis.

Hiring hint: every recent **Intelcan** software developer advert explicitly flags *"strong C/C++ on Linux"* and *"experience with embedded or real-time systems"* as must-haves (embedded linux developer jobs in montréal, qc - Indeed).

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2 | A laser-focused Linux learning path (≈ 12 weeks of evenings)

Phase 0: Get a playground (Tonight)

- Spin up Rocky Linux 9 or Ubuntu 22.04 LTS in VirtualBox/VMware.
- Install the "Development Tools" group (`dnf groupinstall "Development Tools"` or `sudo apt install build-essential clang lldb cmake`) and enable *bridge* networking so you can packet-sniff yourself.

Phase 1: Daily Linux survival (Week 1-2)

Skill	Why	Quick drill
CLI navigation, `man`, `ssh`, `tmux`	You'll spend 90 % of your day in a terminal	Work only in TTY for two days – no file browser
Files, permissions, ACLs, `sudo`, `setfacl`, `umask`	Needed to deploy binaries under strict least-privilege	Write a script that sets correct perms for log/var dirs
Process management: `ps`, `top` / `htop`, `nice`, `taskset`	Realtime threads require CPU pinning/priorities	Spawn a busy loop and re-nice / pin it to a core
Packages & repos (`dnf`, `rpm`, `apt`)	You'll replicate production libs exactly	Build & install a local RPM of `htop`

Phase 2: Coding on Linux (Week 3-5)

1. **C/C++ toolchain**
   - Use `gcc -Wall -Wextra -pedantic -O2` and `clang-tidy` until you get 0 warnings.
   - Learn CMake targets, out-of-tree builds, and `cpack` to produce RPM/DEB.
2. **GDB & Valgrind** – trace a seg-faulting multithreaded program; set breakpoints, watchpoints; run `valgrind --tool=helgrind` for data-race detection.
3. **Git workflow** – feature branches, rebase, `git bisect` (critical for regressions in safety nets).

Phase 3: System-side Linux (Week 6-8)

Topic	Hands-on task
systemd unit files	Write a `sky_demo.service` with `Restart=on-failure`, install it, check `journalctl -u sky_demo`
Networking (`ip`, `ss`, `tcpdump`)	Craft and replay a small ASTERIX Cat 048 UDP packet with Scapy; capture & dissect in Wireshark
Time sync	Configure `chronyd` with PTP hardware timestamping in a VM pair; verify sub-millisecond skew
SELinux basics	Create a custom policy module that allows your demo service to bind a privileged port without turning SELinux off

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Phase 4: Real-time & High-Availability (Week 9-10)

- Recompile a **PREEMPT_RT** kernel; benchmark latency with `cyclictest` (< 50 µs target).
- Set up a two-node HA cluster with `corosync` + `pacemaker`, add a dummy flight-data service, test automatic fail-over.

Phase 5: Domain specifics (Week 11-12)

- **ASTErIX & CPDLC**: parse live Mode-S/ADS-B using `dump1090` → write a small C++ program that converts it to ASTERIX Cat 062.
- **Qt 5/6 GUI**: replicate a minimalist radar PPI – use `QOpenGLWidget` to draw moving targets and conflict rings.
- **CI simulation**: build a Docker-based Jenkins pipeline that compiles, runs unit tests, packages an RPM, and spins a QEMU VM to execute an end-to-end smoke test.

Putting it together for the interview

1. **Portfolio** – push the tiny radar PPI & ASTERIX converter to GitHub; link in your résumé.
2. **Story** – show you understand the *mission-critical* culture (redundancy, safety, standards like ICAO Doc 4444).
3. **Questions to ask them** –
   - Which Linux flavour and kernel version is SkyControl ATM certified on?
   - Do you use PREEMPT_RT or tuned-profiles for latency?
   - How is HA handled – Pacemaker or proprietary heartbeat?

- What static-analysis & coding standards (MISRA C / CERT C++) are enforced?

Demonstrating that you already use *their* vocabulary and have built a stripped-down mock-up of a SkyControl workflow will make "lack of prior Linux experience" disappear as a concern.

📦 Phase 0 Spin-up the Playground (Tonight)

Step	Command / Action	Checks
0-1	Create a VM with 4 vCPU + 8 GB RAM, bridge-networked.	`ip a` should show the VM on your LAN.
0-2	Enable EPEL & dev tools: `sudo dnf install epel-release -y``sudo dnf groupinstall "Development Tools" -y`	`gcc --version` shows ≥ 11.x
0-3	Add convenience tools: `sudo dnf install cmake git vim tmux htop tcpdump wireshark gdb valgrind clang clang-tools-extra -y`	`wireshark --version` works (run with sudo or add your user to *wireshark* group).

🗺️ Phase 1 Daily Linux Survival (Week 1)

1. **Terminal boot-camp**

```
# switch to a pure TTY (Ctrl+Alt+F3) and live here for an hour
cd /var/log
sudo less secure
history | tail
```

2. **Permissions drill** – create a log dir for a future service:

```
sudo mkdir -p /var/log/sky_demo
sudo chown skyuser:skyuser /var/log/sky_demo
sudo chmod 750 /var/log/sky_demo
```

3. **Process juggling**

```
yes > /dev/null &
top            # note PID
```

```
sudo renice -n -10 <PID>
sudo taskset -c 2 <PID>
```

4. **RPM exercise** – build & install `htop` from source:

```
git clone https://github.com/htop-dev/htop
cd htop && ./autogen.sh && ./configure \
  --prefix=/usr && make -j$(nproc)
sudo checkinstall   # creates and installs an RPM
```

🛠️ Phase 2 Coding on Linux (Weeks 3–4)

2-A Create a baseline CMake project

```
mkdir ~/code && cd ~/code
git init radar_demo
cd radar_demo
touch CMakeLists.txt main.cpp
```

`CMakeLists.txt`

```
cmake_minimum_required(VERSION 3.18)
project(radar_demo LANGUAGES CXX)

set(CMAKE_CXX_STANDARD 20)
add_executable(radar_demo main.cpp)
```

`main.cpp`

```
#include <iostream>
int main() { std::cout << "SkyControl demo\n"; }
```

```
cmake -B build && cmake --build build -j
./build/radar_demo
```

2-B Static-analysis gate

```
clang-tidy main.cpp -- -I.
```

Configure **`clang-tidy`** in `CMakeLists.txt` so the CI fails on warnings.

2-C Debug-cycle

1. Add a deliberate bug (`int* p=nullptr; *p=4;`)
2. Run `gdb ./build/radar_demo` → `run` → examine crash.
3. `valgrind ./build/radar_demo` to catch leaks / invalid writes.

🌐 Phase 3 System-side Linux (Weeks 5–6)

3-A systemd service

```
sudo useradd -r -s /sbin/nologin skyuser
sudo nano /etc/systemd/system/sky_demo.service
```

```
[Unit]
Description=Sky demo flight-data service
After=network.target

[Service]
User=skyuser
ExecStart=/usr/local/bin/sky_demo    # will install later
Restart=on-failure
AmbientCapabilities=CAP_NET_BIND_SERVICE

[Install]
WantedBy=multi-user.target
```

```
sudo systemctl daemon-reload
sudo systemctl enable --now sky_demo
journalctl -u sky_demo -f
```

3-B Packet crafting & decode

```
sudo dnf install python3-scapy -y
python3 - <<'PY'
from scapy.all import *
pkt = Ether()/IP(dst="239.1.1.1")/UDP(dport=30002)/Raw(b'\x15\x2c...')
sendp(pkt, iface="eth0", loop=0)
PY
sudo tcpdump -ni eth0 udp port 30002 -vv
```

Open Wireshark → *Decode As…* ASTERIX.

3-C Time sync

```
sudo dnf install chrony -y
sudo nano /etc/chrony.conf   # add PTP hardware clock if you have one
sudo systemctl restart chronyd
chronyc tracking
```

3-D SELinux policy snippet

```
sudo ausearch -m avc -ts recent
# use audit2allow to generate:
sudo audit2allow -a -M sky_demo_local
sudo semodule -i sky_demo_local.pp
```

⚡ Phase 4 Realtime & HA (Weeks 7–8)

4-A PREEMPT_RT kernel

```
sudo dnf install rpmdevtools -y
# download Rocky RT SRC RPM, then:
rpmbuild --rebuild kernel-rt-*.src.rpm
sudo dnf install ~/rpmbuild/RPMS/x86_64/kernel-rt-*.rpm
sudo grubby --set-default /boot/vmlinuz-*-rt*
```

Reboot → `uname -a` should show `PREEMPT_RT`.

Benchmark:

```
sudo cyclictest -t4 -p99 -n -i200 -d0 -l100000
# Verify max latency <50µs
```

4-B Two-node HA lab

- VM-A: `10.0.0.11`, VM-B: `10.0.0.12`, quorum via UDP multicast.

```
sudo dnf install corosync pacemaker pcs -y
sudo systemctl enable --now pcsd
sudo passwd hacluster
sudo pcs cluster auth vmA vmB -u hacluster
sudo pcs cluster setup skycluster vmA vmB --force
sudo pcs cluster start --all
```

```
sudo pcs property set stonith-enabled=false
sudo pcs resource create sky_demo systemd:sky_demo op monitor
interval=5s
```

Pull power on vmA → ensure vmB promotes the service.

✈️ Phase 5 Domain Demo (Weeks 9–10)

5-A ADS-B → ASTERIX converter

```
sudo dnf install libzmq-devel
git clone https://github.com/flightaware/dump1090
# Run dump1090 --net --interactive &
# Write a C++ program that connects on port 30003, translates to Cat
062, sends via UDP 239.1.1.1:30002
```

5-B Qt radar PPI

```
sudo dnf install qt6-qtbase-devel qt6-qtmultimedia-devel -y
qtcreator &
# In Qt Creator, New → Qt Widgets App
# Draw a QOpenGLWidget; in paintGL() plot blips received from the UDP
converter.
```

5-C CI pipeline

Install Docker & Jenkins:

```
sudo dnf install podman-docker -y
docker pull jenkins/jenkins:lts
docker run -d --name jenkins -p 8080:8080 -v
jenkins_home:/var/jenkins_home jenkins/jenkins:lts
```

- Jenkinsfile (in repo root):*

```
pipeline {
  agent any
  stages {
    stage('Build') {
      steps { sh 'cmake -B build && cmake --build build' }
    }
    stage('UnitTests') {
```

```
      steps { sh 'ctest --test-dir build' }
    }
    stage('Package') {
      steps { sh 'cpack -G RPM --config build/CPackConfig.cmake' }
    }
    stage('Spin QA VM') {
      steps { sh './scripts/qemu_smoketest.sh build/*.rpm' }
    }
  }
}
```

`scripts/qemu_smoketest.sh` boots a cloud-init Rocky image, installs the RPM, starts `sky_demo`, and asserts it emits UDP on 30002 (use `nc -u -l 30002` inside guest + `timeout`).

🎤 Interview Day: Show & Tell

1. **GitHub repo** with:
   - `sky_demo` service, CMake, RPM spec.
   - ADS-B → ASTERIX converter.
   - Screenshot/GIF of Qt PPI displaying live plots.
   - Jenkinsfile + QEMU test script.
2. **Slide or README** summarizing:
   - PREEMPT_RT latency figure.
   - HA fail-over demo (graphs from `pcs status`).
   - SELinux "allow" diff proving policy discipline.

📚 Reference cheat-sheet

Task	Man page / doc
Packaging	`rpmbuild`, `checkinstall`, `cpack`
Real-time	`man tuned-adm`, `Documentation/rt/` (kernel tree)
HA	pcs(8), pacemaker(7)
ASTERIX	EUROCONTROL Doc 032

Follow the order, log every command, and in ~10 weeks you'll have concrete proof that you **work the same way Intelcan's SkyControl team works**—even if today you've never touched Linux.