Porting CAV-Ready Controller Software Across ATC Platforms

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ITS TEXAS

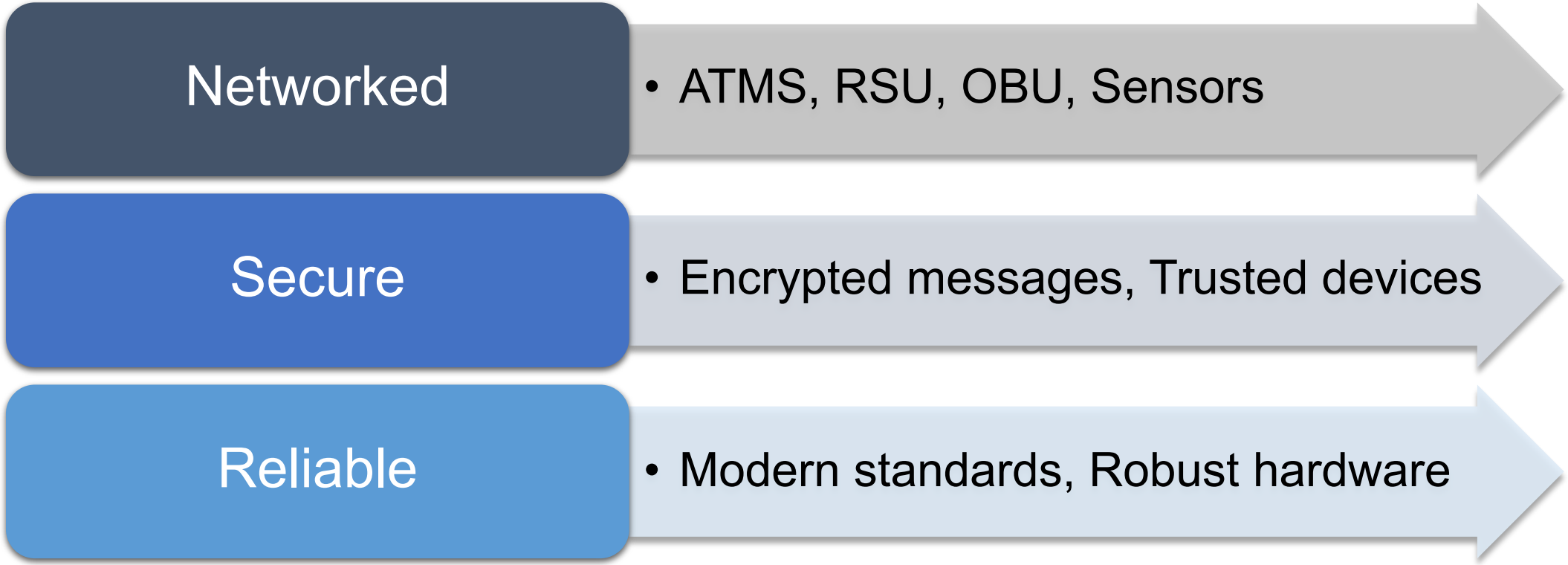
Evolution of ITS

- Increase in traffic congestion & vehicular traffic density
- Newer technologies highly effective at reducing urban travel times & traffic congestion
  - ATMS with traffic signal optimization, adaptive signal control, CAV systems – Expanded ITS ecosystem
  - Highly connected systems & “system of systems”
  - Rich data-driven solutions
- Newer technologies & applications rely heavily on the computing & communication capabilities at intersections
  - Need for traffic controllers to be capable and CAV-ready

The Basics of CAV and Traffic Signal Controllers

- CAV equipped and able to “talk” to infrastructure
  - Make real-time decisions (speed up, slow down, change lane)
- Traffic Signal Controller run lights at intersections
  - Determine sequence, flow

Connected & “Smart” Intersections

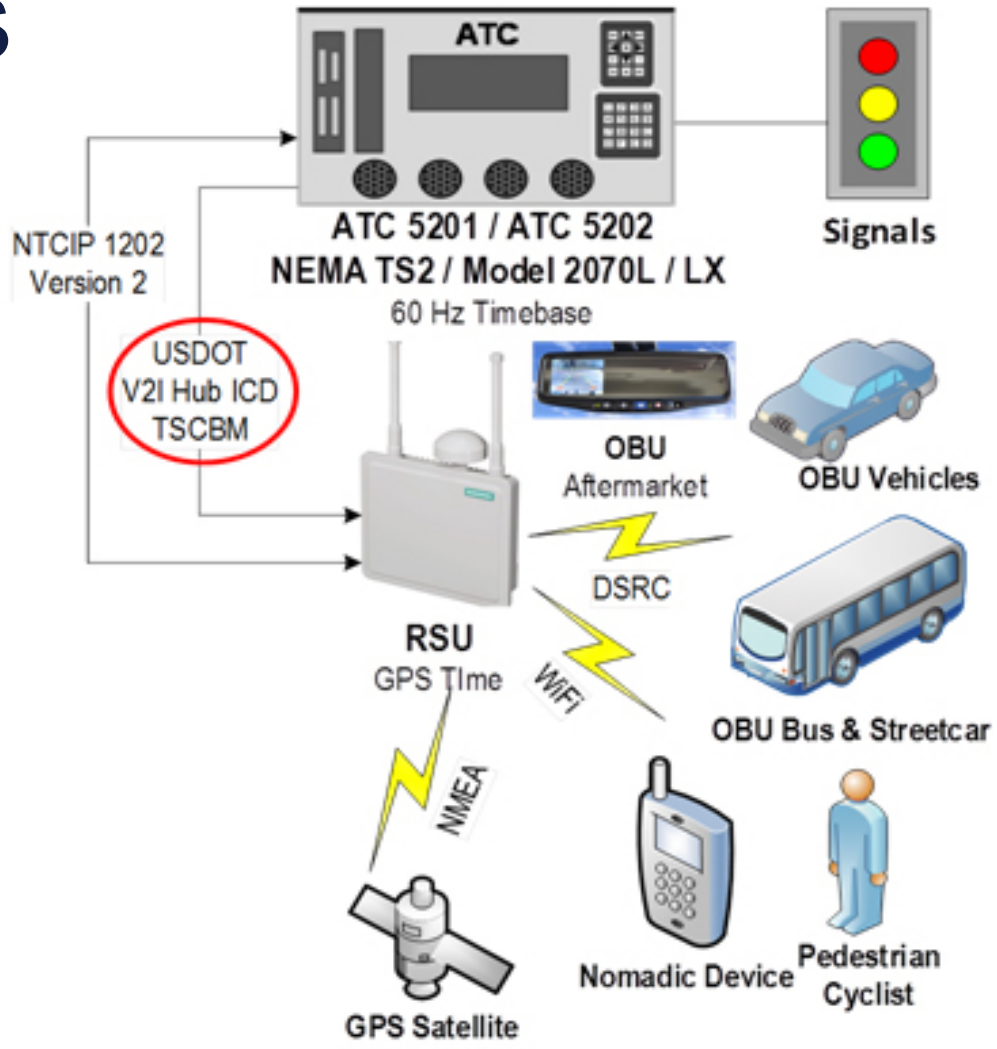


Traffic Controller Needs for CAV Deployment

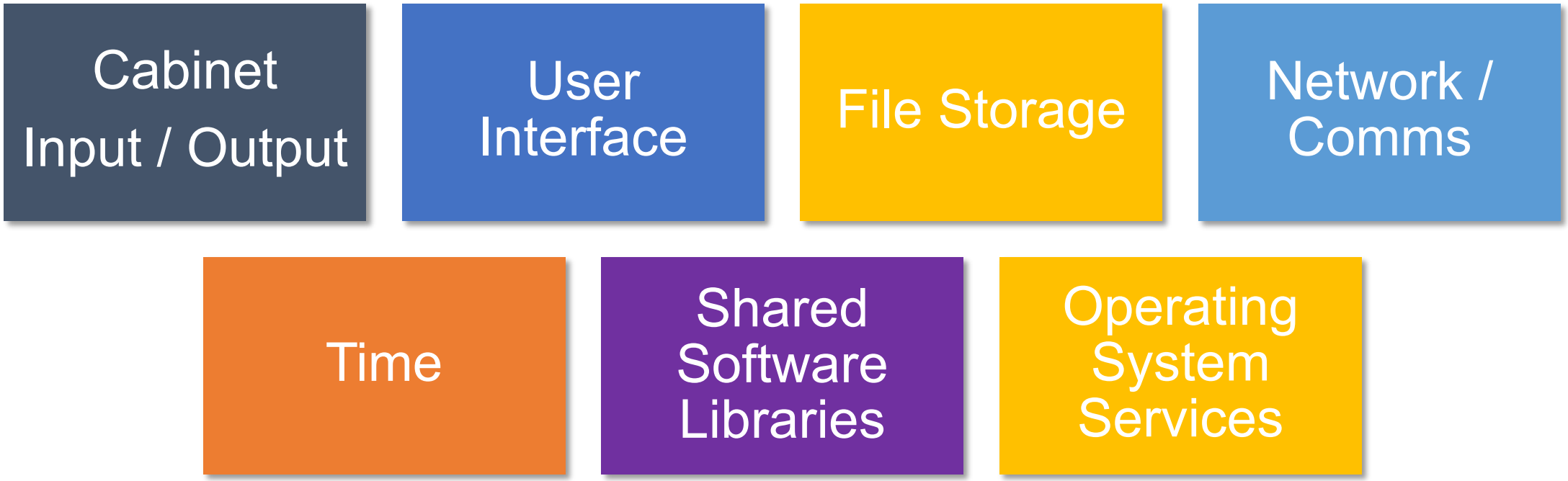
- Controller Hardware
  - Old controllers – not CAV capable
  - Older and unsupported OS & firmware
- Networking
  - Capable, reliable, and secure network connection needed at the intersection
- Logistical & Financial considerations
  - Replacing all installed controllers is cost-prohibitive for most agencies
  - Replacing installed controllers may also require central system change

ATC Traffic Controllers

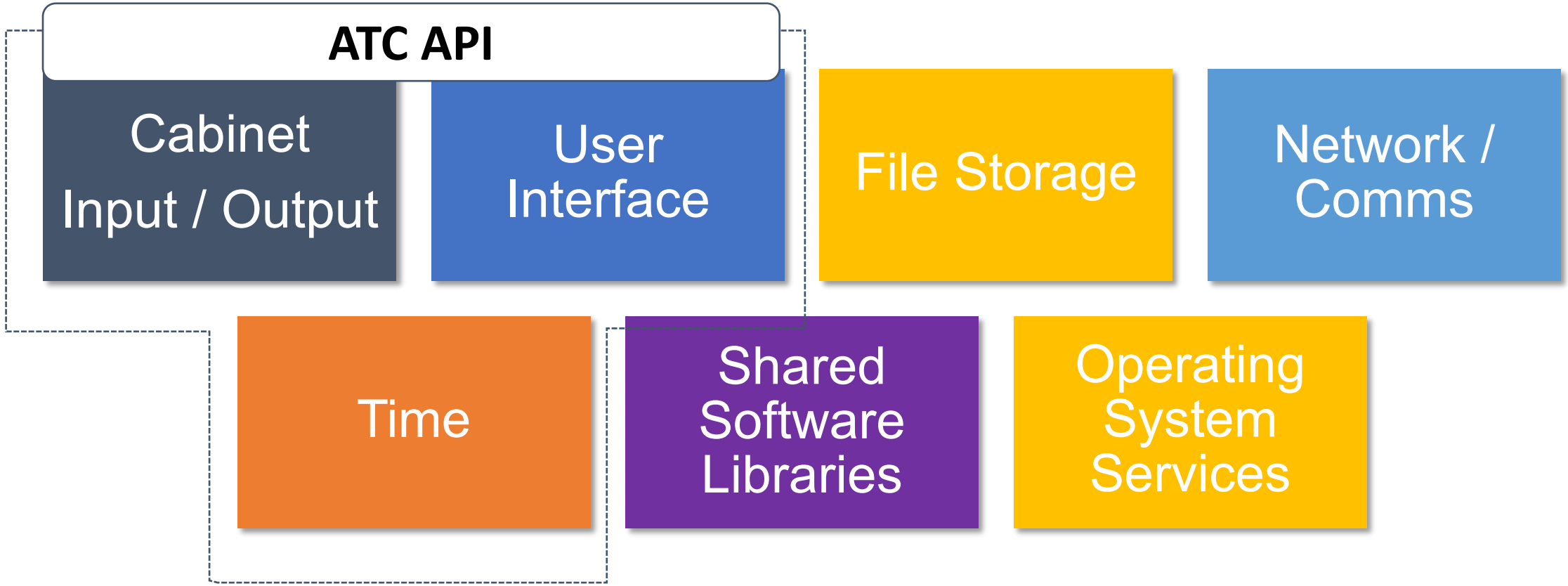
- ATC5201 Version 6 standard calls for a higher level of resources & performance
- Open software tools
- Tens of thousands of currently deployed controllers conforming to Version 6 standard



ATC Software Sub-system Interfaces



ATC Software Interfaces



ATC 5401 - focused on these three subsystems
Application Programming Interface

Porting Methods and Scope

- Tested 4 different makes of traffic controllers with 8 hardware variants
- Validated ATC 5.2 and 6.25 compliance
- Tools for characterizing and validating controller hardware:
  - Device Acceptance Test (DAT) programs
  - Test fixtures
  - Serial terminals
  - Digital oscilloscopes

Connected and Autonomous Vehicle Applications

- SAE J2735 – SPaT and MAP data
- ICD-2009 (TSCBM) messaging for CAV devices
- Signal Performance Measures
- Signal Request Messaging for Priority/Preemption Vehciles

Observations

- Clock interfaces, line synchronization, compliance, services, and accuracy were different among different ATC manufacturers
- Front Panel keypad and display behaved differently
- Front Panel Activity LED access was different
- Datakey presence check was different

Observations

- Responsiveness and accuracy of I/O devices were different
- 6 MB file storage on some devices (ATC 5.2), 16 MB file storage on newer controllers (ATC 6.25)
  - Linux OS, applications, logs, SPM, configuration, MAP, SPaT, etc.
- Shared software services for encryption and other functions were different
- Different OS versions – very old versions on some controllers

Conclusion

- ATC 6.25+ (and above) compliance significantly stabilizes controller operations across manufacturers
- Time accuracy requires GPS or another syncing device same as RSU
- ATC API and ATC standard helps consistency & interoperability
- More standard requirements & compliance will make it even more convenient to support CAV-ready software on different ATC controllers

Best Practices for Implementation

- **Invest in Research and Development**: Continuous R&D in communication technologies can yield new solutions for integration challenges.
- **Engage Stakeholders Early**: Collaborate with government agencies, traffic signal manufacturers, and CAV developers from the outset to ensure alignment on goals and standards.
- **Pilot Programs**: Conduct pilot projects to test interoperability solutions before wide-scale implementation.

References

Interoperability	▪ All standards required for interoperability in 5.895-5.925 GHz band published ▪ Initial standards and architecture extending interoperability beyond 5.895-5.925 GHz band established	▪ 3 device suppliers and 2 OEMs demonstrate interoperability among products in an operational deployment ▪ 2 SCMS providers demonstrate interoperable security credentials management following secure by design principles ▪ 5 certified devices on the market	Private sector, with DOT and IOO support

1. ATC 5201 v6.25(6.34 proposed) –controller compliance
2. ATC 5301 (ATC Cab), 5401 (ATC API)– ITS Standards
3. NTCIP 1202v3(v4 kickoff)(objects), 1209 (TSS data elements), 1211 (control & prioritization)
4. Institute of Transportation Engineers (ITE)
5. International Transportation Engineers Institute of Electrical and Electronics Engineers (IEEE).
6. Society of Automotive Engineers (SAE) - messaging side
7. 5G Automotive Association (5GAA) - manufacturer membership side
8. Saving Lives with Connectivity: A Plan to Accelerate V2X Deployment (US DOT August 2024)

Thank You!

- **Robby Wheeler, PE**
- **Econolite Senior Principal Engineer**
- **512-689-6524**
- **Rwheeler@Econolite.com**