NordiaSoft

An Innovator for Software Defined Systems

Performance of SCAv4.1 vs SCAv2.2.2

Presented by

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Outline

About NordiaSoft

SCA v4.1 vs. SCA v2.2.2 metrics

New SCA v4.1 features

Who is NordiaSoft?

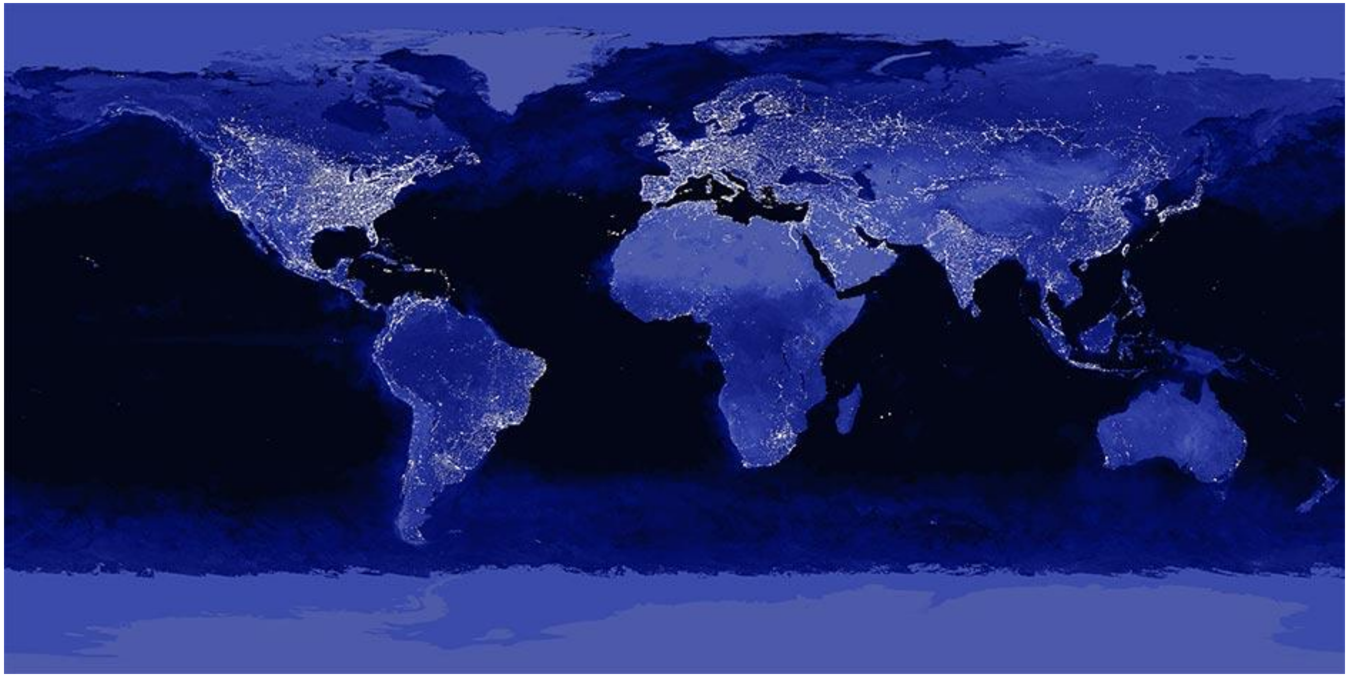
- **A strategic partner for the development of complex heterogeneous embedded distributed systems (HEDS)**

- **Located in Gatineau, Québec, Canada**
  - All started at the Communications Research Centre Canada (CRC)
  - NordiaSoft was launched in 2013
  - Team with over 15 years of R&D in embedded system software

- **Specialises in high-end HEDS products**
  - Military and public safety radios
  - Test and Instrumentation equipment
  - Radar, Electronic Warfare, SigInt
  - Robotics, Control rooms
  - Transport (Automobile, Avionics, Train, Ship)

NordiaSoft Technology Around the World

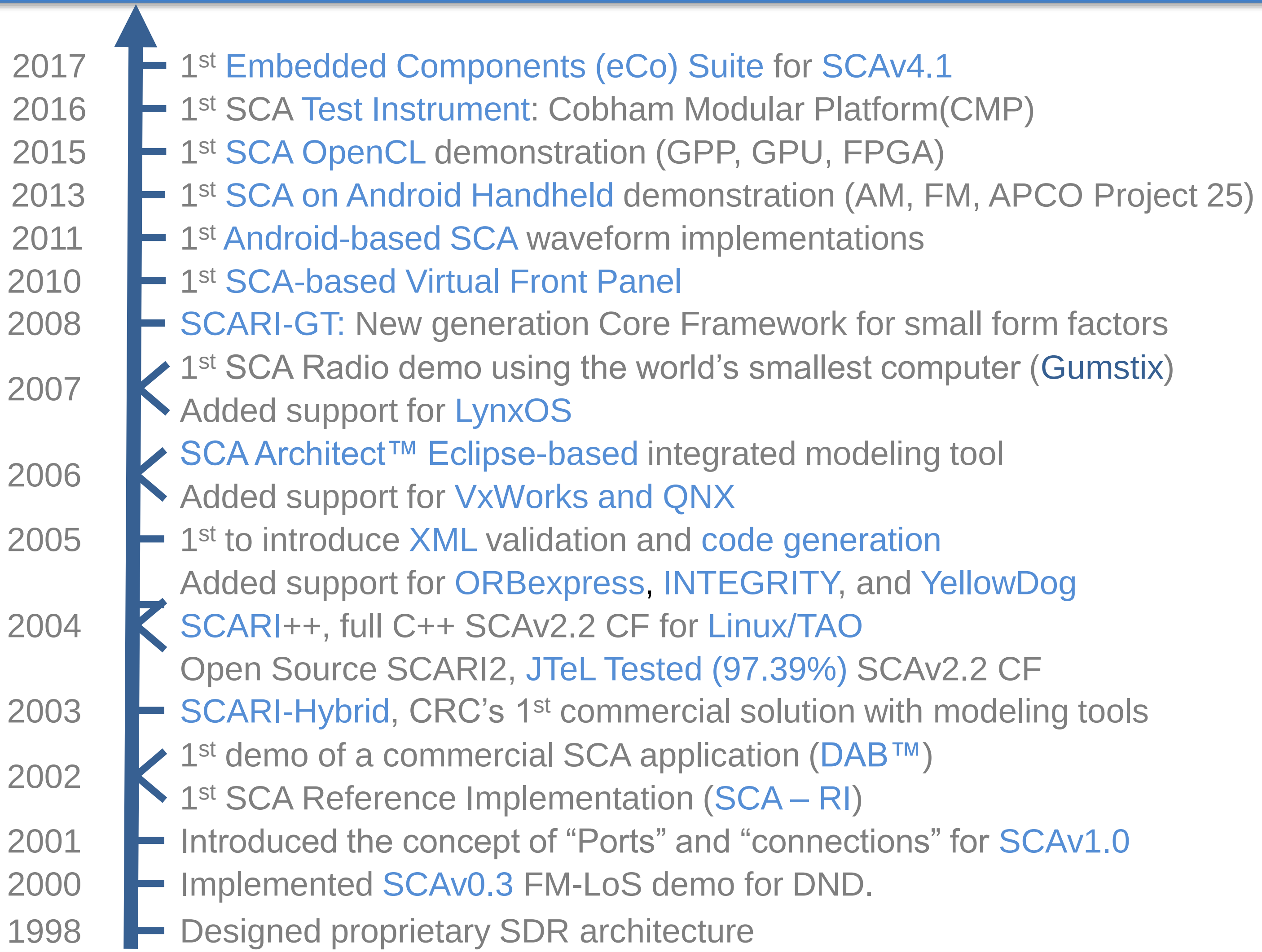
- **Technology licensed to over 50 clients in 16 countries**
  - Americas, Europe, Middle-east, Asia
  - Over 10 waveforms deployed on thousands of SCA radios



NordiaSoft Partners

- **Platforms Partners**
  - Cobham AvComm
  - Ettus Research
  - Spectrum Signal Processing by Vecima
  - More coming…
- **Real Time Software Partners**
  - Wind River
  - Green Hills Software
  - Objective Interface Systems
  - More coming…
- **Certification Testing Partners**
  - Reservoir Labs
  - More coming…

NordiaSoft's Team: List of Industry Firsts…



2017	1st Embedded Components (eCo) Suite for SCAv4.1
2016	1st SCA Test Instrument: Cobham Modular Platform(CMP)
2015	1st SCA OpenCL demonstration (GPP, GPU, FPGA)
2013	1st SCA on Android Handheld demonstration (AM, FM, APCO Project 25)
2011	1st Android-based SCA waveform implementations
2010	1st SCA-based Virtual Front Panel
2008	SCARI-GT: New generation Core Framework for small form factors
2007	1st SCA Radio demo using the world's smallest computer (Gumstix)
	Added support for LynxOS
2006	SCA Architect™ Eclipse-based integrated modeling tool
	Added support for VxWorks and QNX
2005	1st to introduce XML validation and code generation
2004	Added support for ORBexpress, INTEGRITY, and YellowDog
	SCARI++, full C++ SCAv2.2 CF for Linux/TAO
	Open Source SCARI2, JTeL Tested (97.39%) SCAv2.2 CF
2003	SCARI-Hybrid, CRC's 1st commercial solution with modeling tools
2002	1st demo of a commercial SCA application (DAB™)
	1st SCA Reference Implementation (SCA – RI)
2001	Introduced the concept of "Ports" and "connections" for SCAv1.0
2000	Implemented SCAv0.3 FM-LoS demo for DND.
1998	Designed proprietary SDR architecture

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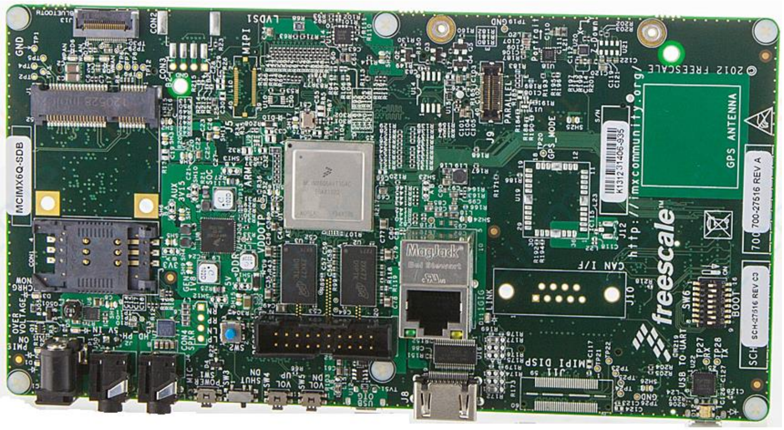
New SCA v4.1 features

Test bench characteristics

- **Processor**
  - NXP iMX.6Quad 1GHz (ARM Cortex-A9 Quad Core)
- **Memory**
  - DDR3-1066, 2GByte 533Mhz, 64 bit bus
- **Storage**
  - SDHC, speed 10, 32GByte
- **OS**
  - Linux 3.14 (IMX6 QD)
- **OE**
  - NordiaSoft 3rd generation SCARI CF v2.2.2 vs NordiaSoft 1st generation Embedded Components (eCo) Hub CF v4.1



Outline

Node Boot Up: Device Registration

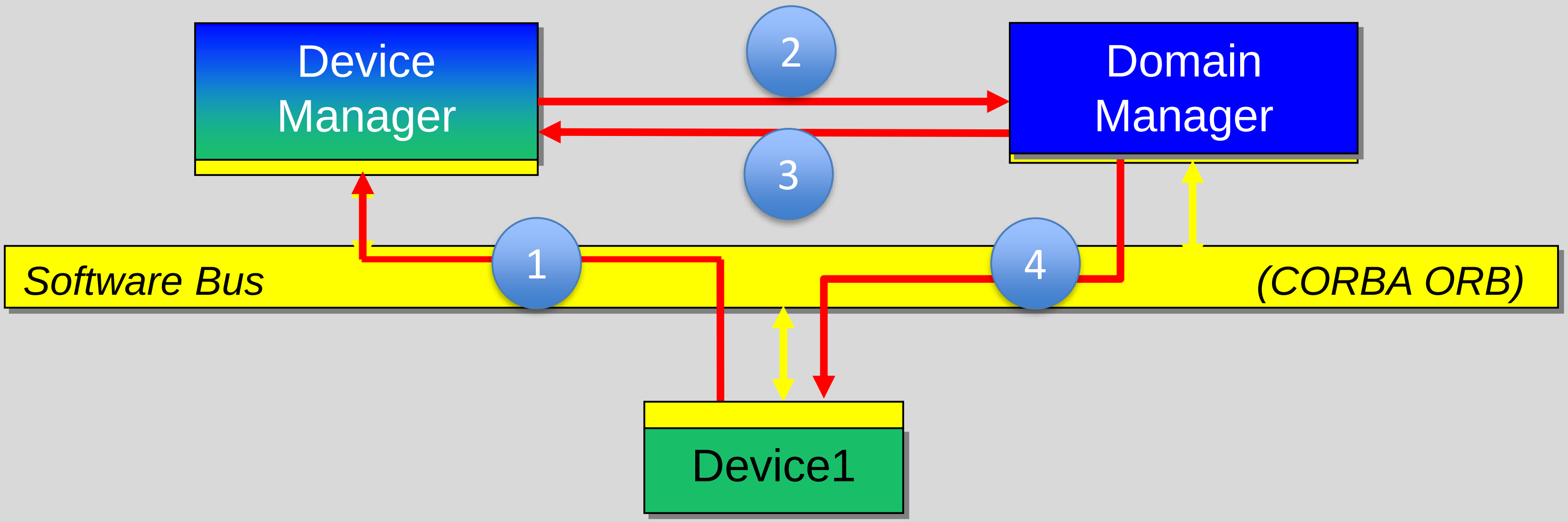
Assembly Deployment: Mass Connections

Application Deployment: Application Creation

Feature: Registration

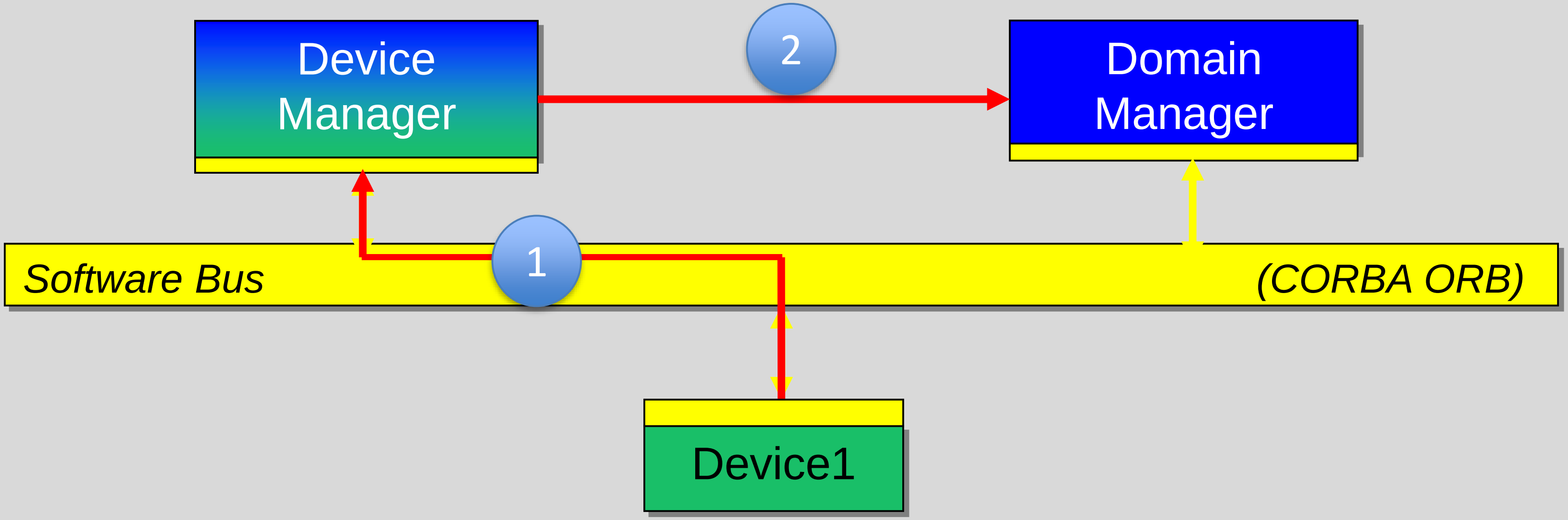
- **SCAv4.1 uses push only registration**
  - SCAv2.2.2 was mostly implemented by letting key components pull the information they needed
  - SCAv4.1 is focused on allowing components to provide more information at registration to avoid pulling
  - This feature can save several interactions to copy metadata files over embedded file systems (major concern for radios with slow file systems)
  - It can also help avoid reparsing of some XML information
  - The result is a faster boot sequence

Feature: Registration SCAv2.2.2



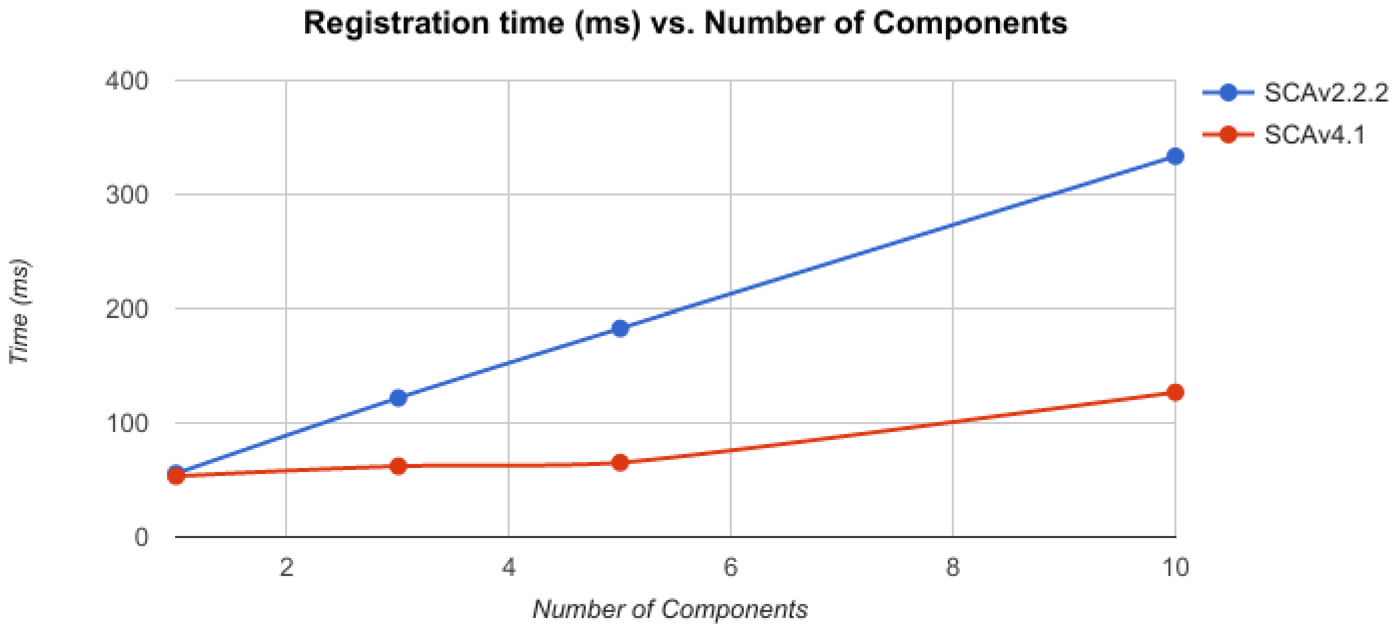
1. *Device* registers with its *DeviceManager*
2. *DeviceManager* registers *Device* with *DomainManager*
3. *DomainManager* requests *Device* info from DeviceManager
4. *DomainManager* requests from *Device* Software Profile (SPD/PRF) to extract advertised capabilities

Feature: Registration SCAv4.1



1. *Device* registers with its *DeviceManager*
2. *DeviceManager* registers *Device* with *DomainManager*

Feature: Registration



# Components	Time (ms) SCAv2.2.2	Time (ms) SCAv4.1	Improvement %
1	55.705	53.263	4.38%
3	121.93	62.075	49.09%
5	182.928	65.246	64.33%
10	333.542	126.867	61.96%

Outline

Node Boot Up: Device Registration

Assembly Deployment: Mass Connections

Application Deployment: Application Creation

Feature: Mass Connections

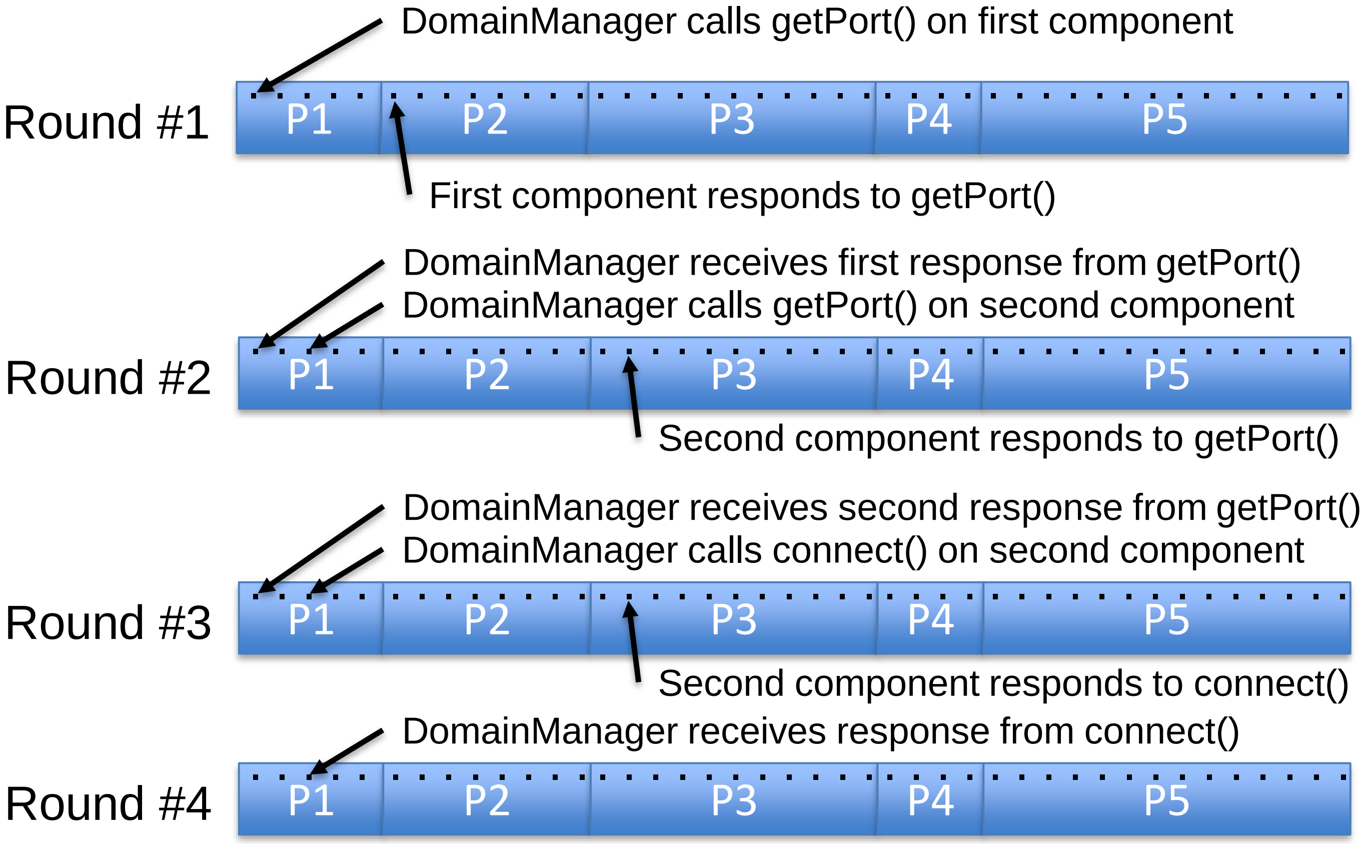
- **SCAv4.1 also supports the push approach to establish connections between components**
  - Components can register all their ports during registration
  - Connections can be established in bulk
  - The result is a shorter connection sequence
- **Mass connections can provide substantial improvements for secure radios**
  - Secure radios need to keep red and black information separated
  - The Multiple Independents Levels of Security (MILS) is often used
  - MILS relies on RTOS with separate partitions (like ARINC 653)
  - …

Feature: Mass Connections

- **Mass connections can provide tremendous improvements for secure radios (…)**
  - Using SCAv2.2.2, making a connection requires 2 calls to getPort() and 1 call to connect()
  - CORBA is fast, on normal systems, many connections can be performed in milliseconds
  - However, establishing connections between components hosted in different partitions can require up to 4 rounds of the secure scheduler
    - Can be very slow for several connections
    - Typical systems has minimum of 20 connections, some have over 100

Feature: Mass Connections

- **Mass connections can provide tremendous improvements for secure radios (…)**



DomainManager calls getPort() on first component

Round #1

First component responds to getPort()

DomainManager receives first response from getPort()
DomainManager calls getPort() on second component

Round #2

Second component responds to getPort()

DomainManager receives second response from getPort()
DomainManager calls connect() on second component

Round #3

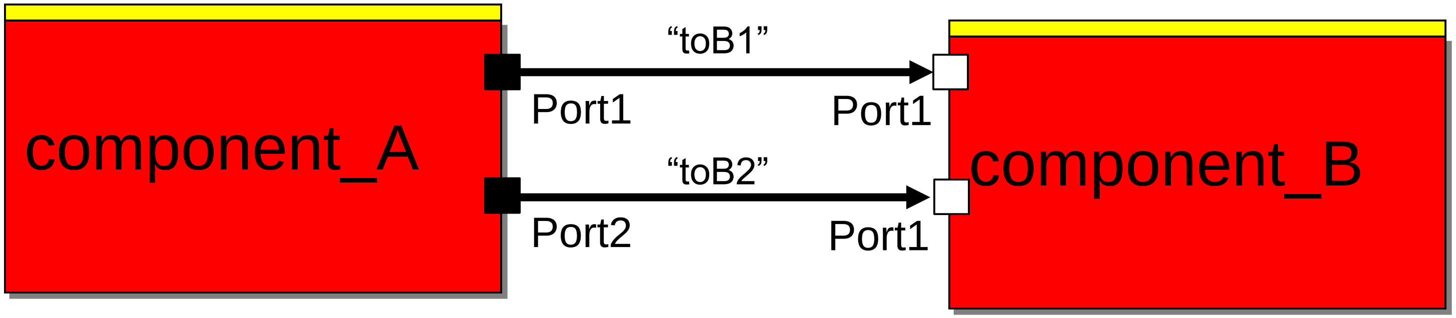
Second component responds to connect()

DomainManager receives response from connect()

Round #4

Feature: Mass Connections

- **SCAv2.2.2**

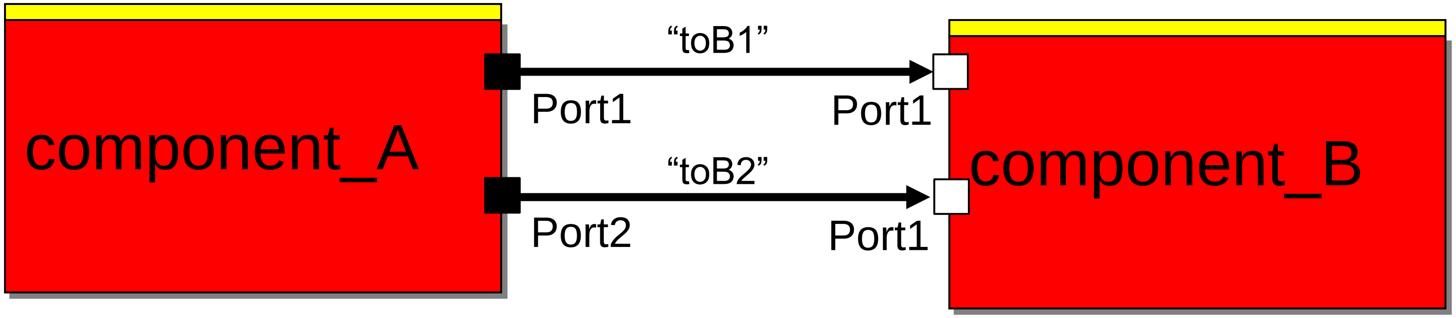


- Connections

portA1 = component_A.getPort("Port1")
portB1 = component_B.getPort("Port1")
portA1.connectPort(portB1, "toB1")
portA2 = component_A.getPort("Port2")
portB2 = component_B.getPort("Port2")
portA2.connectPort(portB2, "toB2")

Feature: Mass Connections

- **SCAv4.1**

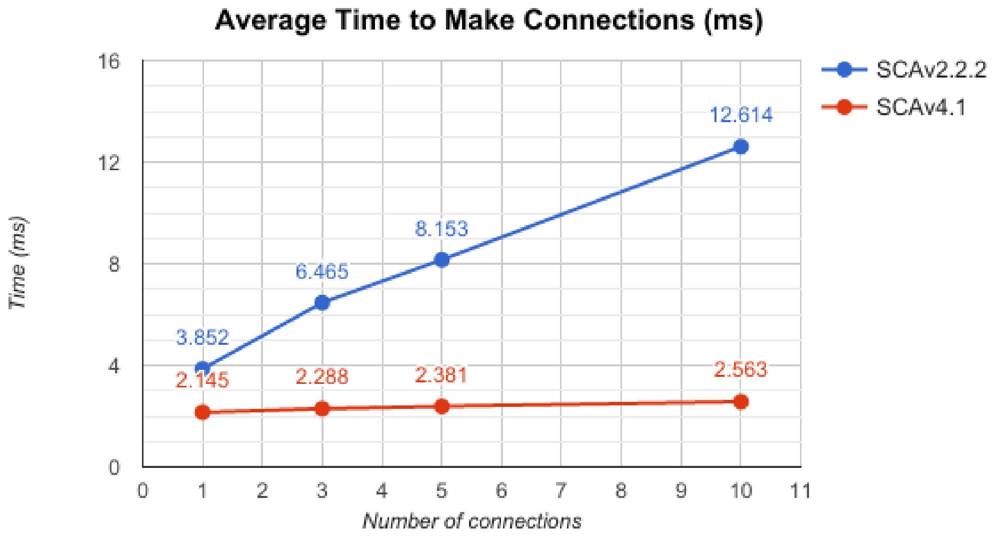


  - Connection

    All provides port references are obtained at registration

    component_A.connectUsesPorts("Port1", "toB1", "Port2", "toB2"…)

Feature: Mass Connections



# of connections		SCAv.2.2.2	Average time per connection	SCAv4.1	Average time per connection	Improvement
1 connection	1	3.852	1.118	2.145	0.133	44.31%
3 connections	3	6.465	1.307	2.288	0.071	64.61%
5 connections	5	8.153	1.075	2.381	0.118	70.80%
10 connections	10	12.614	0.974	2.563	0.209	79.68%
		Base Cost	2.734		2.012	

Outline

Node Boot Up: Device Registration

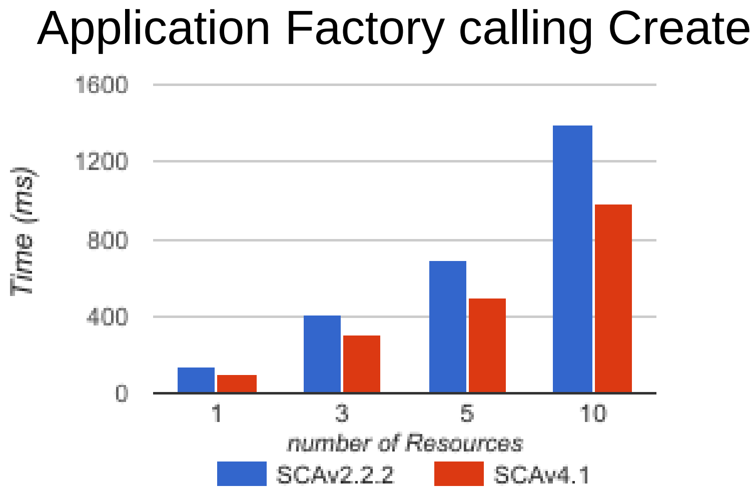
Assembly Deployment: Mass Connections

Application Deployment: Application Creation

Feature: Application Creation

- **Application Deployment Time is Paramount**
  - SCAv4.1 utilizes less component interactions to launch SCA Applications
  - SCAv4.1 reduces footprint while preserving equivalent functionality
  - The result is a faster application creation

Feature: Application Creation



Number of Resources	SCAv2.2.2	SCAv4.1	Improvement
1	136.661	104.147	23.79%
3	408.392	304.178	25.52%
5	685.381	495.727	27.67%
10	1392.28	989.534	28.93%

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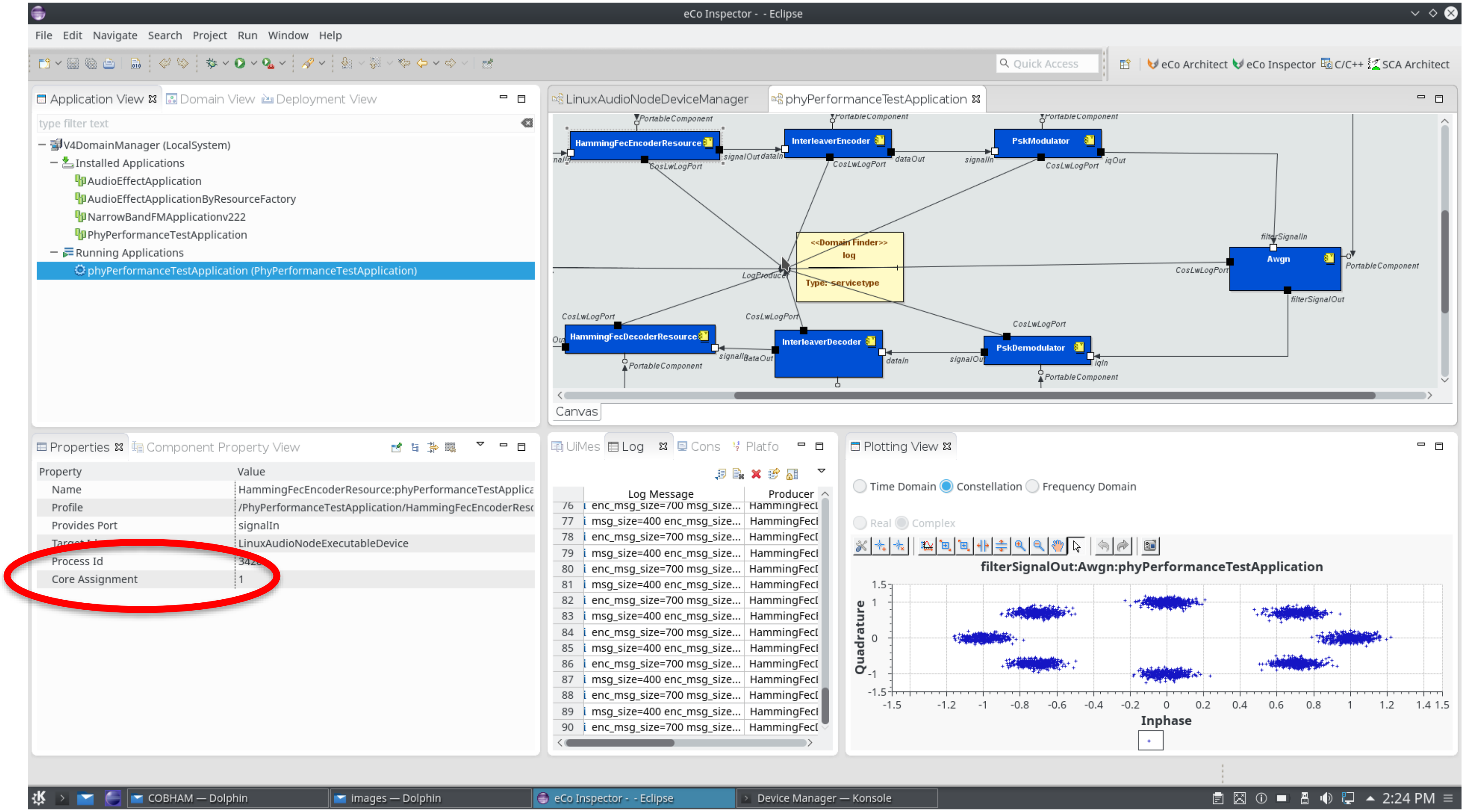
Outline

- Core Assignment
- Component Factories
- Process Allocation
- Backwards Compatibility
- Optional Composition

Core Assignment

- **SCAv2.2.2 does not support Core Assignment**
- **SCAv4.1 leverages full capabilities of multicore platforms**
  - Deterministic control over component deployment
  - Override core allocation control from the OS
- **Component Core Assignment**
  - Optimize throughput (core collocation)
  - Maximize parallel processing (core separation)
- **Overall gains**
  - Enhance performance by distributing execution across multiple cores
  - Reduce costs by fully utilizing existing computing infrastructure
  - Save power by requiring fewer processors

Core Assignment



eCo Inspector - - Eclipse

Application View

- V4DomainManager (LocalSystem)
  - Installed Applications
    - AudioEffectApplication
    - AudioEffectApplicationByResourceFactory
    - NarrowBandFMApplicationv222
    - PhyPerformanceTestApplication
  - Running Applications
    - phyPerformanceTestApplication (PhyPerformanceTestApplication)

Properties

Property	Value
Name	HammingFecEncoderResource:phyPerformanceTestApplica
Profile	/PhyPerformanceTestApplication/HammingFecEncoderResc
Provides Port	signalIn
Target I[illegible]	LinuxAudioNodeExecutableDevice
Process Id	342[illegible]
Core Assignment	1

Log

	Log Message	Producer
76	enc_msg_size=700 msg_size...	HammingFecI
77	msg_size=400 enc_msg_size...	HammingFecI
78	enc_msg_size=700 msg_size...	HammingFecI
79	msg_size=400 enc_msg_size...	HammingFecI
80	enc_msg_size=700 msg_size...	HammingFecI
81	msg_size=400 enc_msg_size...	HammingFecI
82	enc_msg_size=700 msg_size...	HammingFecI
83	msg_size=400 enc_msg_size...	HammingFecI
84	enc_msg_size=700 msg_size...	HammingFecI
85	msg_size=400 enc_msg_size...	HammingFecI
86	enc_msg_size=700 msg_size...	HammingFecI
87	msg_size=400 enc_msg_size...	HammingFecI
88	enc_msg_size=700 msg_size...	HammingFecI
89	msg_size=400 enc_msg_size...	HammingFecI
90	enc_msg_size=700 msg_size...	HammingFecI

Plotting View

○ Time Domain ● Constellation ○ Frequency Domain

○ Real ○ Complex

Component Factories

- **SCAv2.2.2 only supported factories for application components**
  - Allows several components to be co-located in a same program space
  - Provides foot print savings
  - Provides better throughput

- **SCAv4.1 generalizes the Factory concepts to both node and application components**
  - Node components can now be co-located together as well

Component Factories

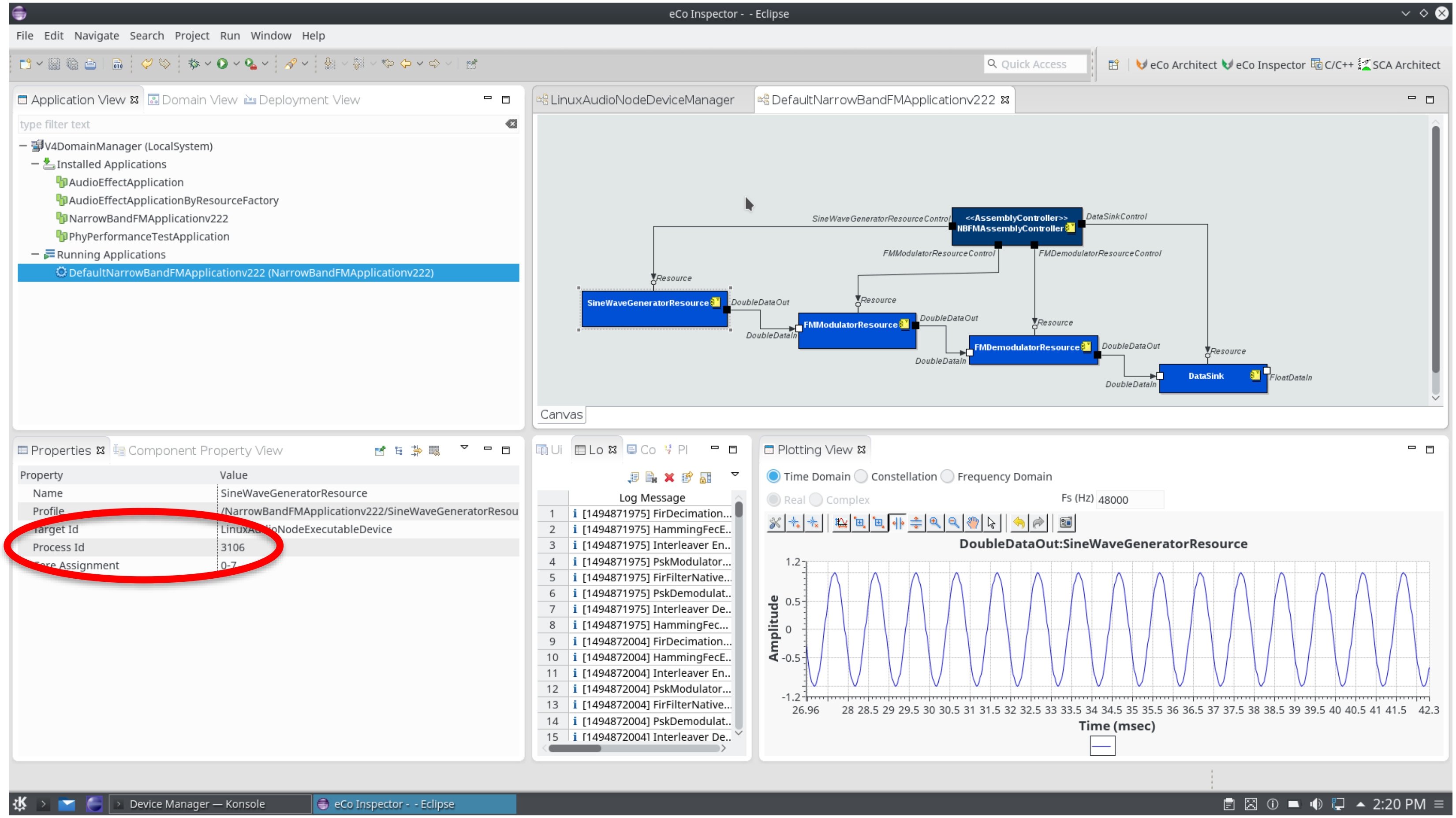
- The feature can also drastically accelerate communications between components with good real time ORBs

Average Round Trip Time in usec for PPC405GPr (400MHz) running INTEGRITY RTOS and ORBexpress	Double Sequence		Octet Sequence	
	1024	2048	1024	2048
using TCP/IP	3334	7272	1428	1767
using INTCONN	2215	4728	1042	1273
using direct method invocation thanks to a ResourceFactory that yielded 40% smaller footprint	244	492	155	231

Process Allocation

- **Allows developers to define within which process a component must be launched**
  - Create any number of program spaces to co-locate any number of components
  - Creation of program processes is completely dynamic
- **Allows application components to be co-located with node components**
  - Allows a high-data rate node component to feed an application within a same program space
- **Overall: Offers substantial potential for performance optimization**

Process Allocation



eCo Inspector - - Eclipse

- V4DomainManager (LocalSystem)
  - Installed Applications
    - AudioEffectApplication
    - AudioEffectApplicationByResourceFactory
    - NarrowBandFMApplicationv222
    - PhyPerformanceTestApplication
  - Running Applications
    - DefaultNarrowBandFMApplicationv222 (NarrowBandFMApplicationv222)

Property	Value
Name	SineWaveGeneratorResource
Profile	/NarrowBandFMApplicationv222/SineWaveGeneratorResou
Target Id	LinuxAudioNodeExecutableDevice
Process Id	3106
Core Assignment	0-7

```
   Log Message
1  i [1494871975] FirDecimation...
2  i [1494871975] HammingFecE..
3  i [1494871975] Interleaver En..
4  i [1494871975] PskModulator...
5  i [1494871975] FirFilterNative...
6  i [1494871975] PskDemodulat..
7  i [1494871975] Interleaver De..
8  i [1494871975] HammingFec...
9  i [1494872004] FirDecimation...
10 i [1494872004] HammingFecE..
11 i [1494872004] Interleaver En..
12 i [1494872004] PskModulator...
13 i [1494872004] FirFilterNative...
14 i [1494872004] PskDemodulat..
15 i [1494872004] Interleaver De..
```

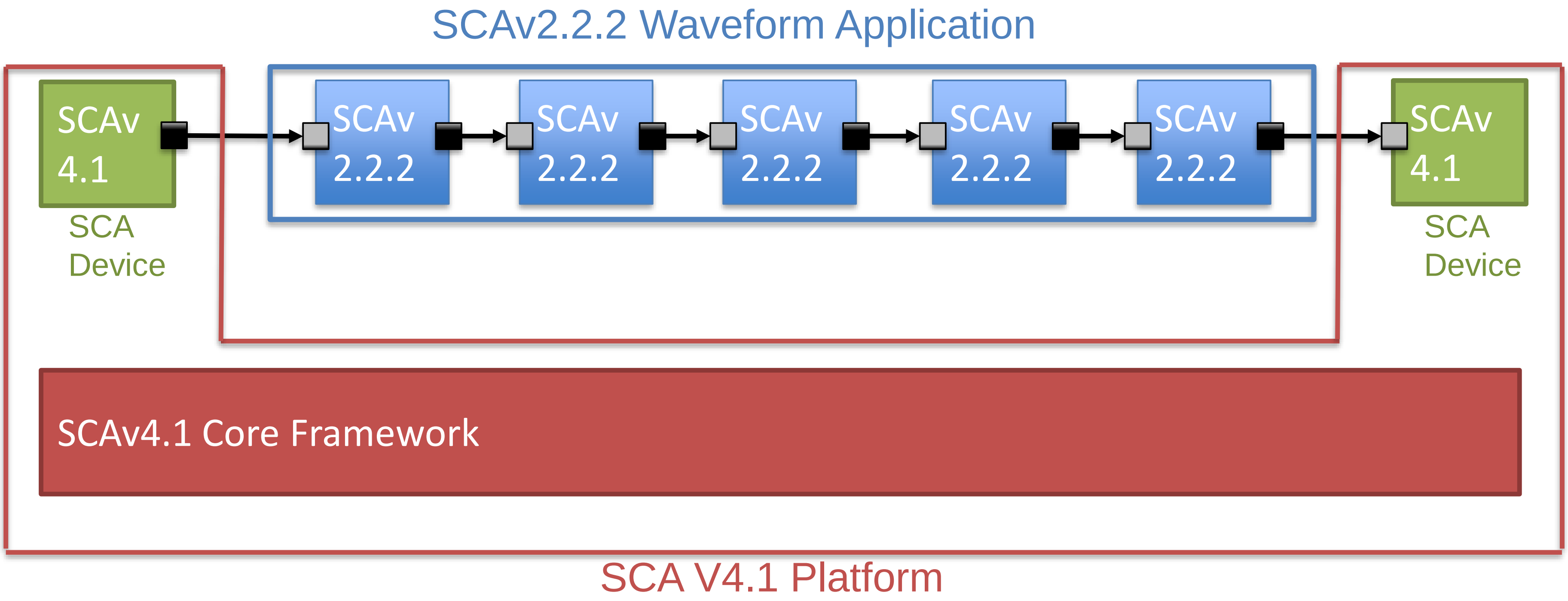
Plotting View

● Time Domain ○ Constellation ○ Frequency Domain

○ Real ○ Complex Fs (Hz) 48000

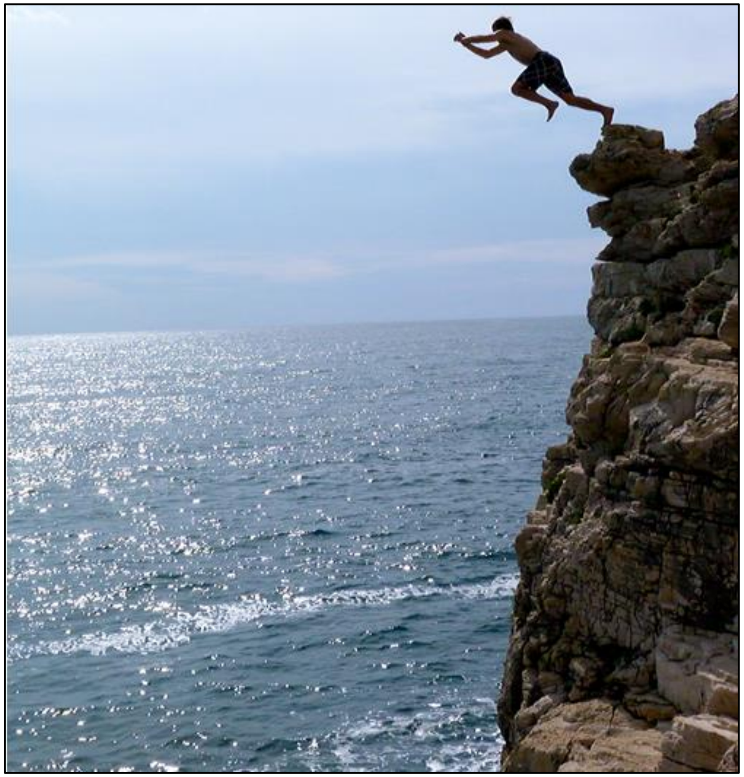
Backwards compatibility

- **Launch SCAv2.2.2 applications on a SCAv4.1 platform**
  - Backwards compatibility with SCAv222



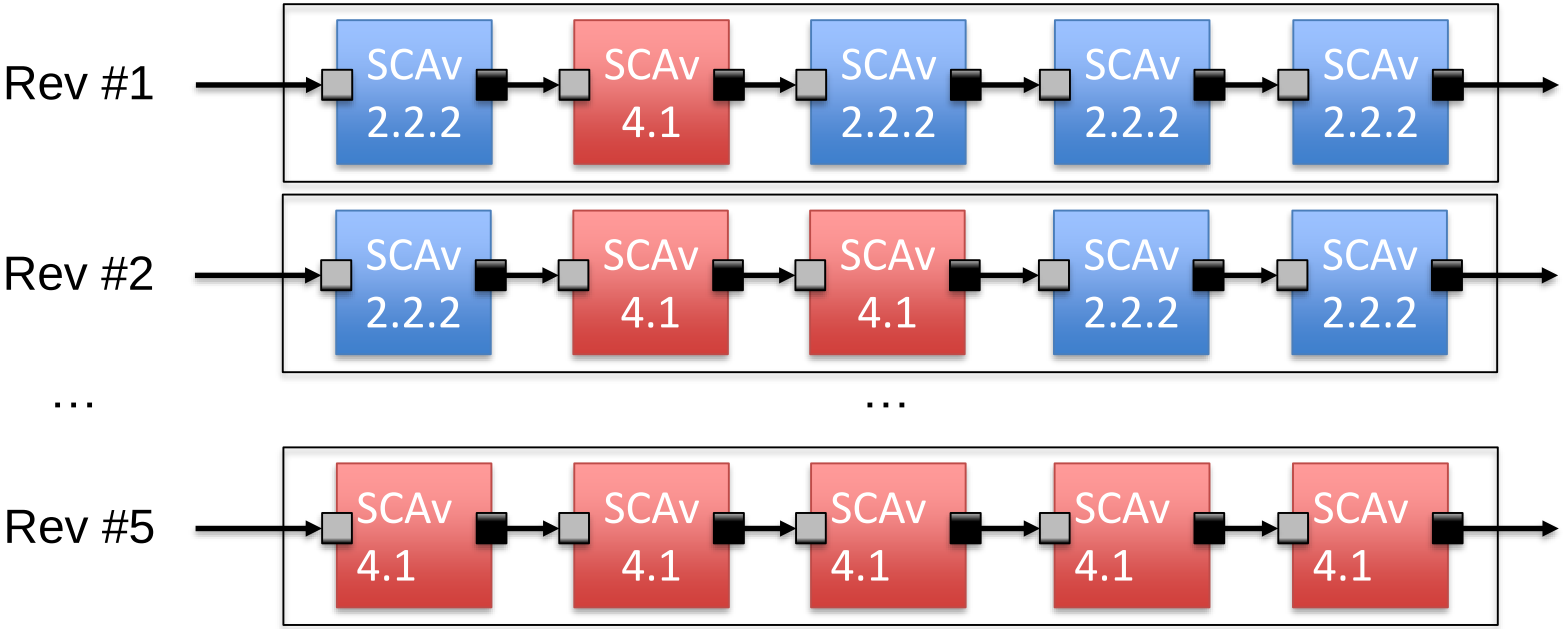
Backwards compatibility

- **Launch SCAv2.2.2 application components as part of SCAv4.1 applications**
  - NordiaSoft extended feature to allow customers to make a progressive transition from SCAv222 to SCAv4
  - Avoid the cliff jump approach



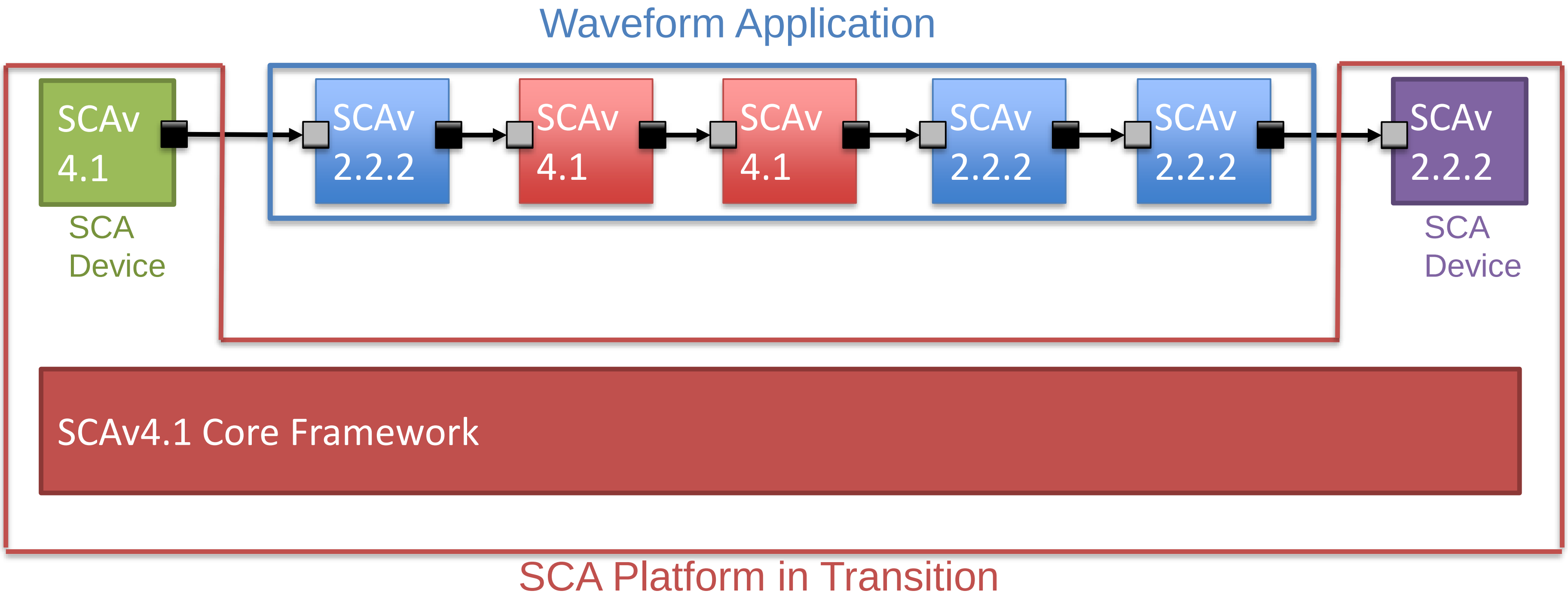
Backwards compatibility

- **Launch SCAv2.2.2 application components as part of SCAv4.1 applications (…)**
  - Why force the port of all the application components before they can be tested? The eCo Core Framework supports application made of a mixture of SCAv2.2.2 and SCAv4.1 components

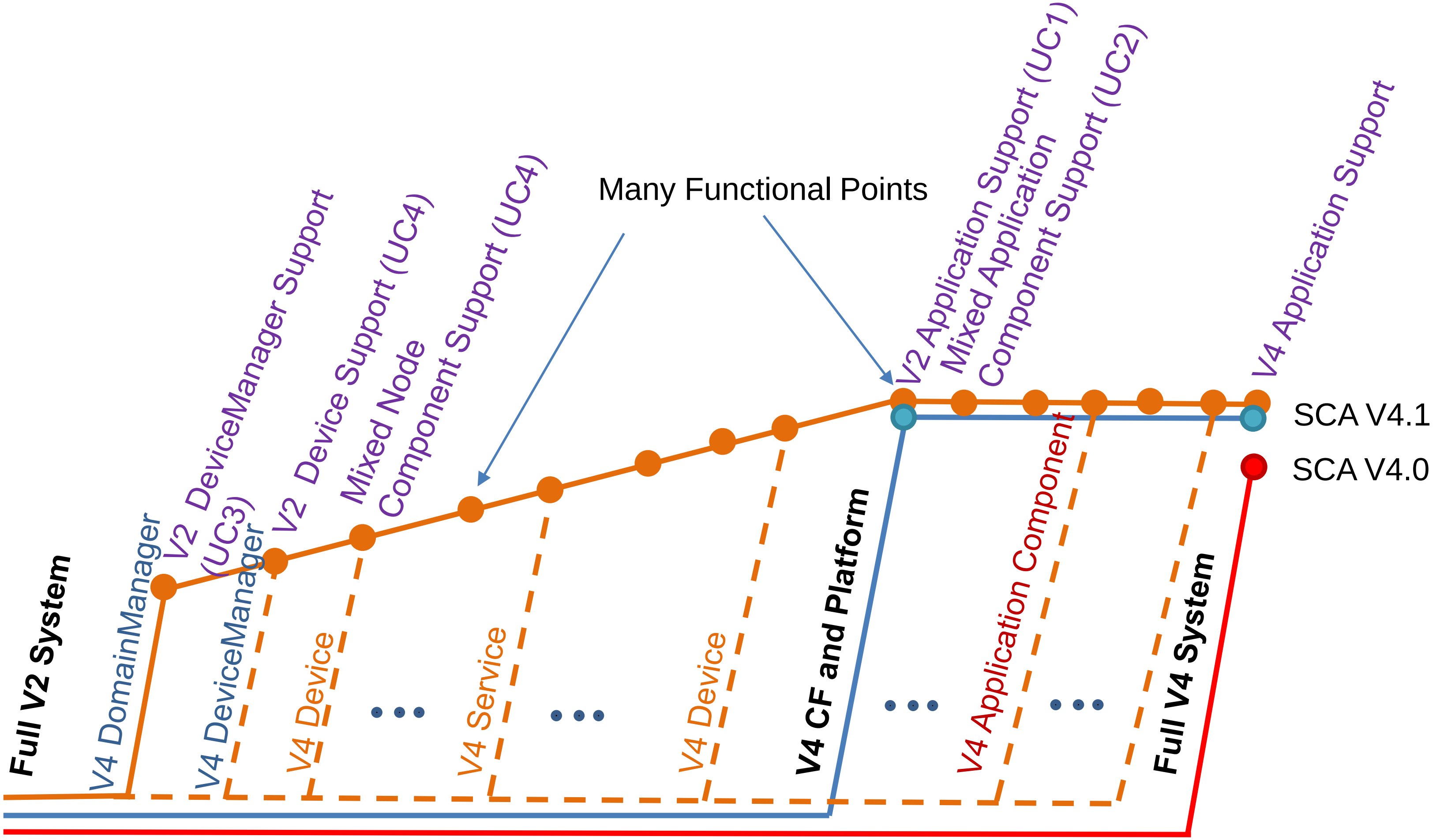


Backwards compatibility

- **The eCo Core Framework even supports a mixture of SCAv2.2.2 node and application components**
  - You can reuse cards/boards from SCAv2.2.2 radios to transition towards a SCAv4.1 compliant radio



Backwards compatibility



Optional Composition

- **SCAv4.1 supports varying levels of granularity for components**
- **Components can implement only the standard interfaces that are required**
  - Ex: a component with no properties doesn’t have to implement the PropertySet interface
- **This can also help address some Information Assurance (IA) requirements**
  - No dead/stubbed code for unsupported APIs
  - No interface to provide information that should not be provided

Conclusion: why use SCAv2.2.2 ?

- **SCAv4.1 provides more features**
  - Adds support for multi-core processors that powers every recent consumer electronics devices
  - Offers more control over information assurance
- **Offers better performances at smaller footprints**
  - Faster startup times thanks to bulk connections and push registration
  - Smaller footprints and better performances thanks to component factories and process space allocation
- **Supports backwards compatibility**
  - SCAv2.2.2 applications can run on SCAv4.1 platforms

The End