



SAVI Testbed Initial Views

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Agenda

- ❖ Introduction
- ❖ VANI Architecture
- ❖ SAVI Testbed
 - ❖ Architecture
 - ❖ Features & Challenges
- ❖ Control and Management
- ❖ Resource Virtualization
- ❖ Resource Management
- ❖ SAVI Testbed Releases
- ❖ Conclusion
- ❖ Backup Slides (Resources Details)



SAVI Testbed (TB)

- ❖ Playground for SAVI research themes

- ❖ Used and built by
 - ❖ SAVI Themes:
 - ❖ Applications Theme
 - ❖ Extended Cloud
 - ❖ Smart Edge
 - ❖ Wireless/Optical
 - ❖ Future Internet projects
 - ❖ Possibly by Researchers outside VANI

- ❖ Testbed Theme members:
 - ❖ *Leon-Garcia (lead), Boutaba, Chow, Ganjali, Li, Litoiu, Rusch, Steffan,* and all other SAVI PIs, 1 engineer, 1 + 4 x ¼ post-docs, 5 grads, 2 interns, 2 undergrads

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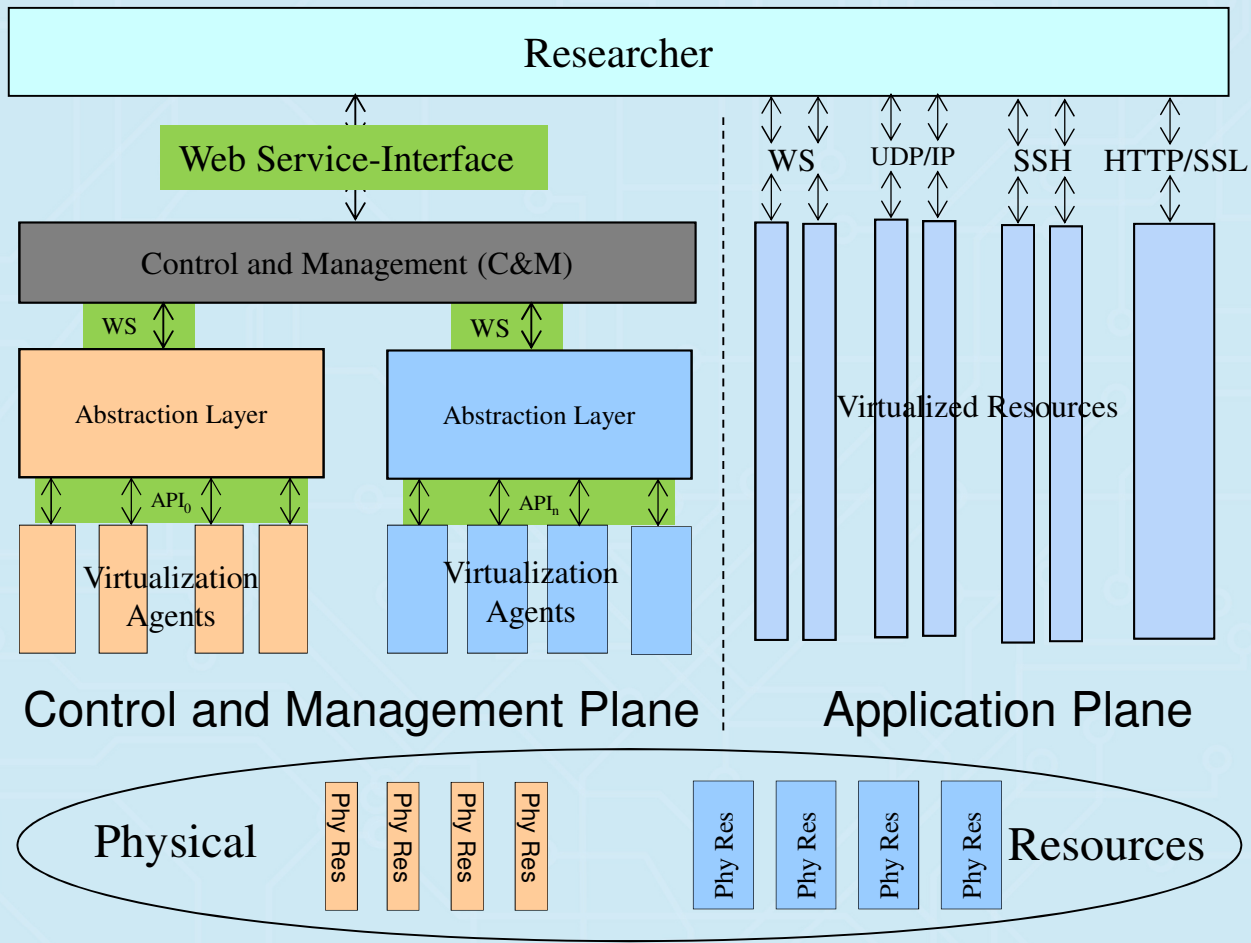
VANI to SAVI

- ❖ Virtualized Application Networking Infrastructure
 - ❖ A networking research testbed
 - ❖ Designed and prototyped at UofT
 - ❖ Based on UofT's Application-Oriented Network architecture

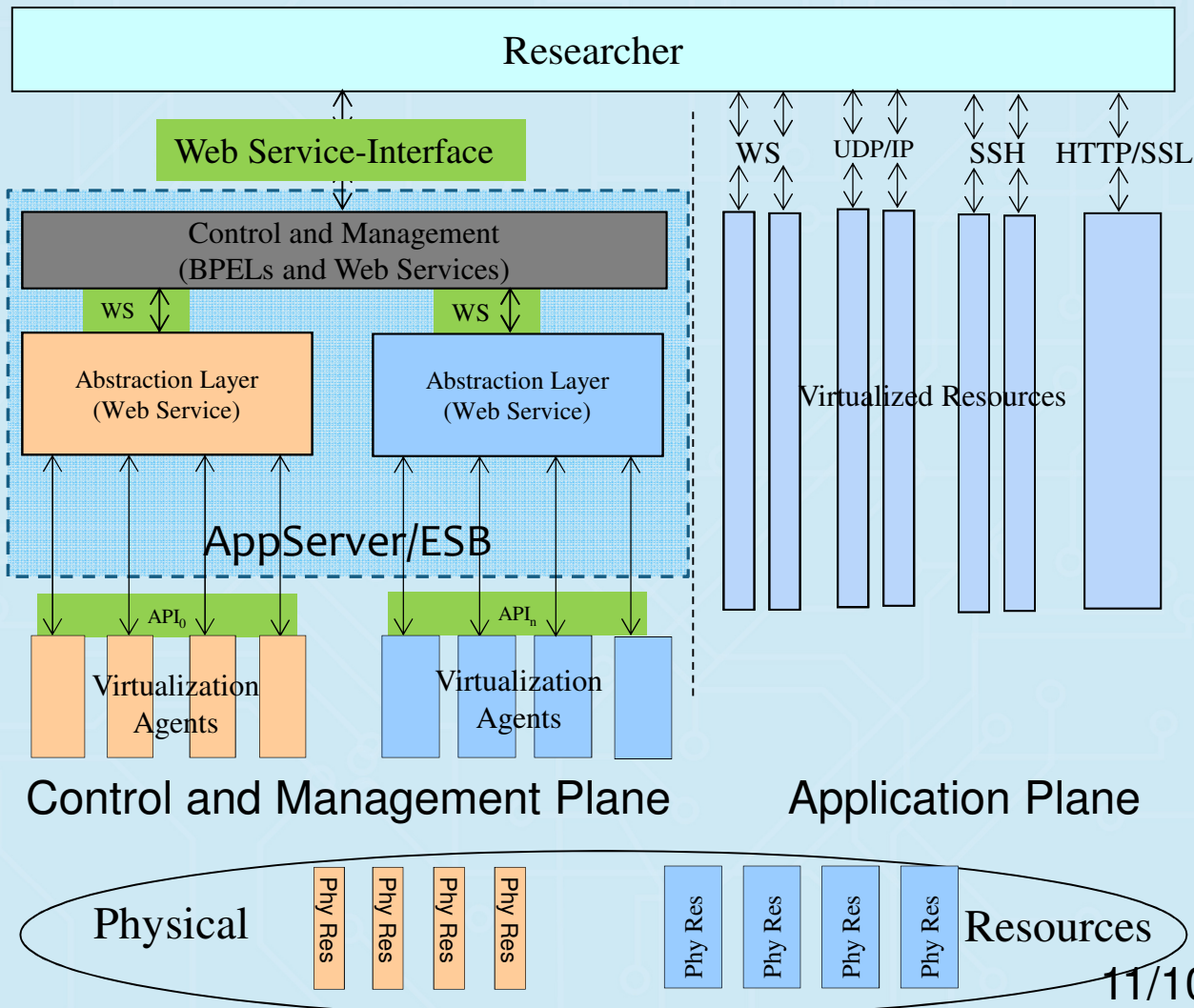
- ❖ SAVI Testbed has roots in VANI
 - ❖ Lessons learnt from VANI
 - ❖ Architecture
 - ❖ Middleware
 - ❖ Development
 - ❖ ...

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VANI Architecture

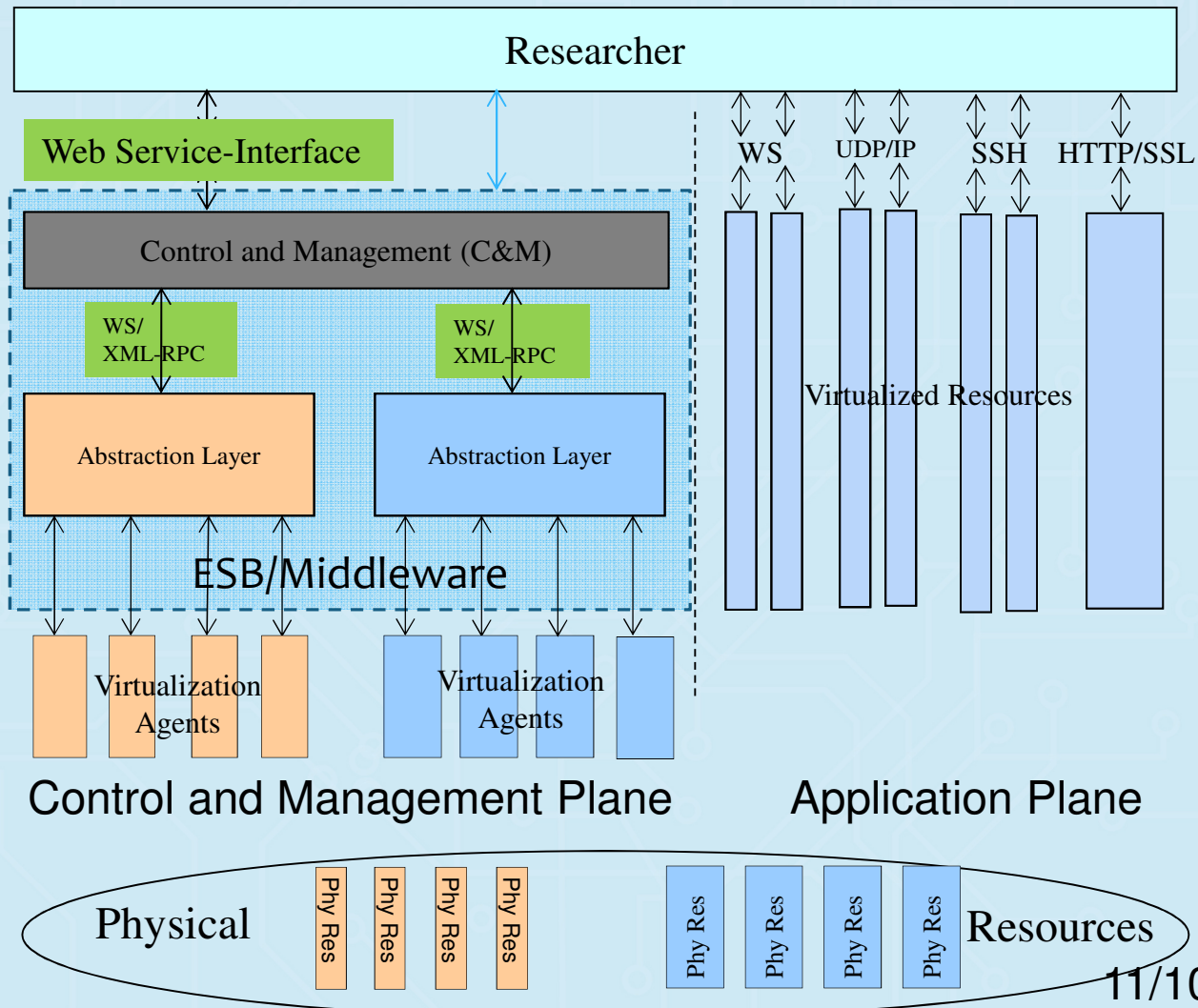


VANI Architecture



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SAVI TB Architecture



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Control and Management

- ❖ Provides access to virtualized resources
- ❖ Handles Auth/Auth/Accounting (AAA)
- ❖ Holds SAVI configuration
- ❖ Facilitates measurement and monitoring
- ❖ Includes advanced services
 - ❖ PaaS
 - ❖ Autonomic Resource Management
 - ❖ ...



SAVI TB Initial Features (VANI)

- ❖ Basic Control and Management Features
 - ❖ Slice Management and Resource Allocation
 - ❖ Configuration Management
 - ❖ Security Management (AAA)
- ❖ Processing Virtualization
 - ❖ Linux vServer
- ❖ Storage Virtualization
- ❖ Reprogrammable HW Resource
 - ❖ BEE2
- ❖ Network Services (IPv4)
 - ❖ Virtualization using Ethernet VLAN
 - ❖ GW Services (NAT, DNS, public-private mapping)

SAVI TB Main Features (Beyond VANI)



- ❖ Advanced Security Management
 - ❖ Authentication/Authorization/Accounting, SingleSignOn, Trust Management, etc.
- ❖ Network Virtualization and Management
 - ❖ OpenFlow, IPv6, Raw Ethernet, Wider Area Ethernet
- ❖ Open-source cloud computing
 - ❖ e.g., openstack (computing, storage, image, network)
- ❖ Reprogrammable HW Virtualization (e.g., BEE3, NetFPGA)
- ❖ Platform as a Service
 - ❖ Adaptive Application and Resource Management
 - ❖ Edge/Cloud Application Deployment
 - ❖ Converged computing and networking resource management
- ❖ Measurement and Monitoring Services



SAVI TB Main Design Decisions

- ❖ Connectivity
- ❖ Security
- ❖ Leveraging work in
 - ❖ Open-source cloud computing
 - ❖ Clean-slate and future Internet projects
- ❖ Providing advanced management services
 - ❖ Converged networking and computing resource management
- ❖ Federation

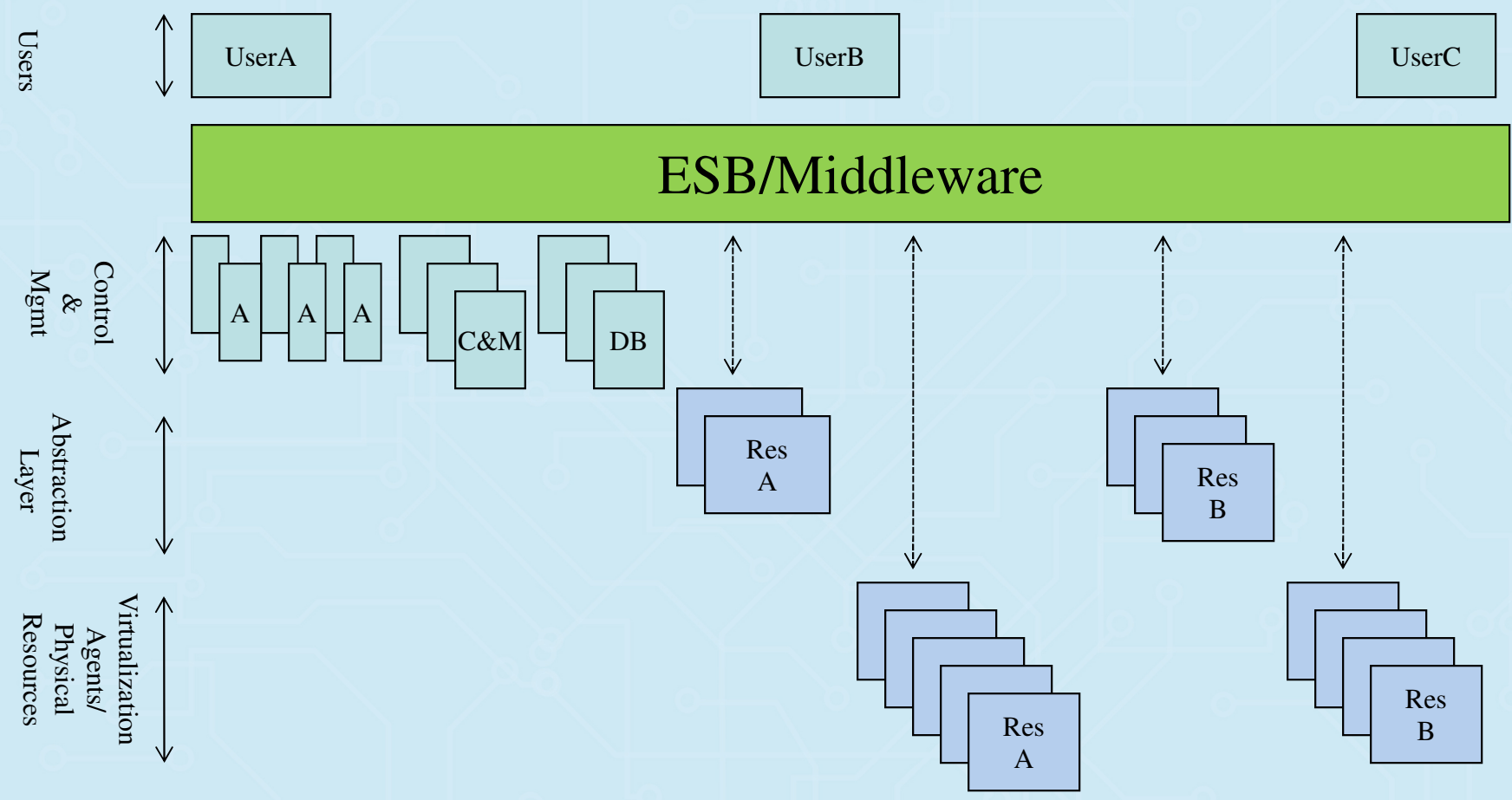


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SAVI Testbed Control & Management Plane



Abstraction Layers

❖ Main Functions:

- ❖ Provide abstraction of resource to SAVI Control and Management SW
- ❖ Follows the API template provided by SAVI-CM
- ❖ Follows a registration process with CM

❖ Other features:

- ❖ Needs to establish trust with CM
- ❖ Could be distributed/redundant
- ❖ Sends notification on resources status/measurements to SAVI-CM,
 - ❖ According to a unified template
 - ❖ May be passed on to researchers

Virtualization Agents

- ❖ Abstraction layer's arms in virtualizing a resource
 - ❖ Usually attached to a physical resource
 - ❖ Customized for each resource
 - ❖ Provides isolation between different slices of resource
 - ❖ Provides SLA to VANI-CM

- ❖ Uses SAVI middleware to communicate with its corresponding abstraction Layer

- ❖ May be able to directly send notification to:
 - ❖ Researcher/SAVI-CM/Accounting/Abstraction Layer

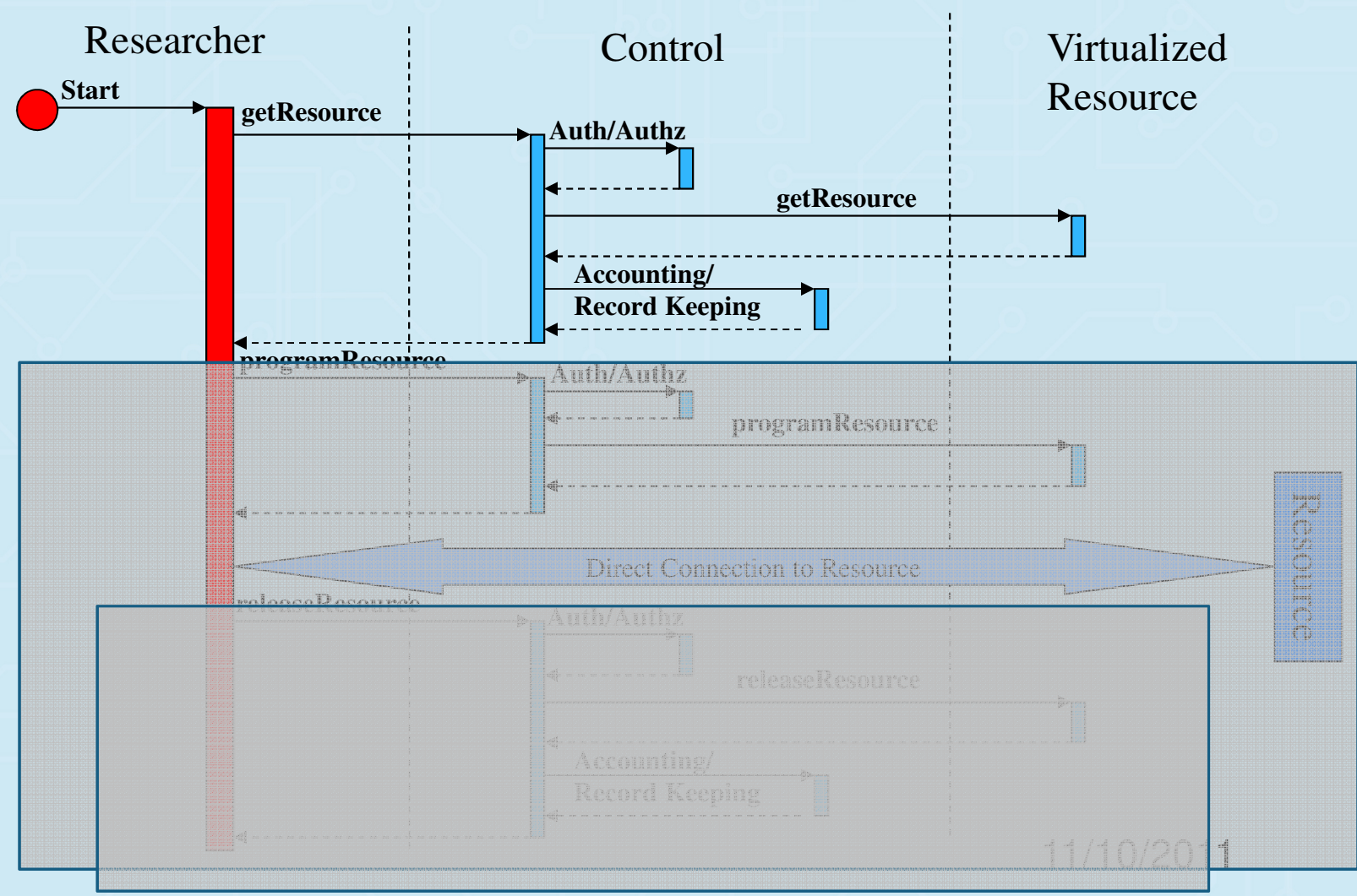


SAVI C&M APIs

- ❖ Different Classes of APIs
 - ❖ Programmable resources
 - ❖ Computing/HW/Sensor resources
 - ❖ Storage resources
 - ❖ Communication/Networking Resources
 - ❖ Wireless/Wired communications

- ❖ Initially follows VANI interface

A Sample Message Sequence



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List of Resources (evolving)

- ❖ Essential resources:
 - ❖ Storage
 - ❖ Processing
 - ❖ Network (Fabric)
 - ❖ Gateway
 - ❖ Reprogrammable HW
- ❖ Secondary Resources
 - ❖ Advanced SAVI developed resources
 - ❖ Resource Management
 - ❖ 3rd party resources

3rd Party Resources

- ❖ Being able to incorporate independently developed resources
 - ❖ Advanced management services
 - ❖ Reusable service components
 - ❖ e.g.: Database, Sensors, Complex Event Processors, ...

- ❖ Challenges
 - ❖ APIs
 - ❖ Middleware and connectivity
 - ❖ Registration
 - ❖ Security and trust
 - ❖ SLAs
 - ❖ ...



Autonomic Resource Management

- ❖ Adaptive Cloud Resource Management
 - ❖ Adapting resource consumption to the usage
 - ❖ Dynamic scaling of applications

- ❖ Network-constrained resource management
 - ❖ Optimum allocation of resources on the cloud and edge nodes
 - ❖ based on networking constraints

- ❖ Adaptive selection of cloud and edge resources

- ❖ Converged computing and networking resource management
 - ❖ Considering constraints and condition of computing, storage, networking, etc.



SAVI TB Releases

- ❖ Follows iterative approach
 - ❖ Delivers in releases
- ❖ Each release adds a subset of features in various areas
 - ❖ Iterative approach will be followed in delivering features as well
 - ❖ Multiple releases before fulfilling a feature
- ❖ Minor releases: ?.x.y
- ❖ Major releases: ?.0.0

- ❖ Goal:
 - ❖ to deliver desirable features by the end of each SAVI Milestone



SAVI Releases

- ❖ SAVI 0.1 := VANI
- ❖ SAVI 0.2 += Min(Openstack-Storage)+Min(OpenFlow) +Min(Identity Manager)
- ❖ SAVI 0.3 += Nmin(Openstack-Storage) + Min(Openstack-compute,network) + Nmin(OpenFlow)+Min(Monitoring)
- ❖ SAVI 0.4 += Min(PaaS)+Nmin(IdMgr)+Nmin(Monitoring)
- ❖ SAVI 0.5 += Nmin(PaaS)+Min(ReprogrammableHW)
- ❖ ...

- ❖ SAVI 3.0 := DETS, OpenFlow, Openstack, Identity Manager and SSO, BEE3/NetFPGA,IPv6,PaaS

Definition of Min/Nmin Features

- ❖ Next/Minimum features are defined at each releases for maximum three releases ahead
 - ❖ In collaboration with:
 - ❖ Members of testbed theme
 - ❖ Other themes leaders and post-docs and other partners
- ❖ Coordinated by testbed architect



Conclusion

- ❖ Initial views on SAVI TB architecture
 - ❖ Starting point, Goals, Challenges

- ❖ SAVI built and used by SAVI researchers (directly/indirectly)

- ❖ Main users/validator of SAVI TB:
 - ❖ Applications theme
 - ❖ Future Internet projects
 - ❖ Researchers outside SAVI
 - ❖ Attracting researchers outside SAVI; extremely important

- ❖ Users are strongly asked to use SAVI testbed releases
 - ❖ To help choose the right path in testbed design and development