



# Planning data intensive workflows on inter-domain resources using the Network Service Interface (NSI)

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System and Network Engineering

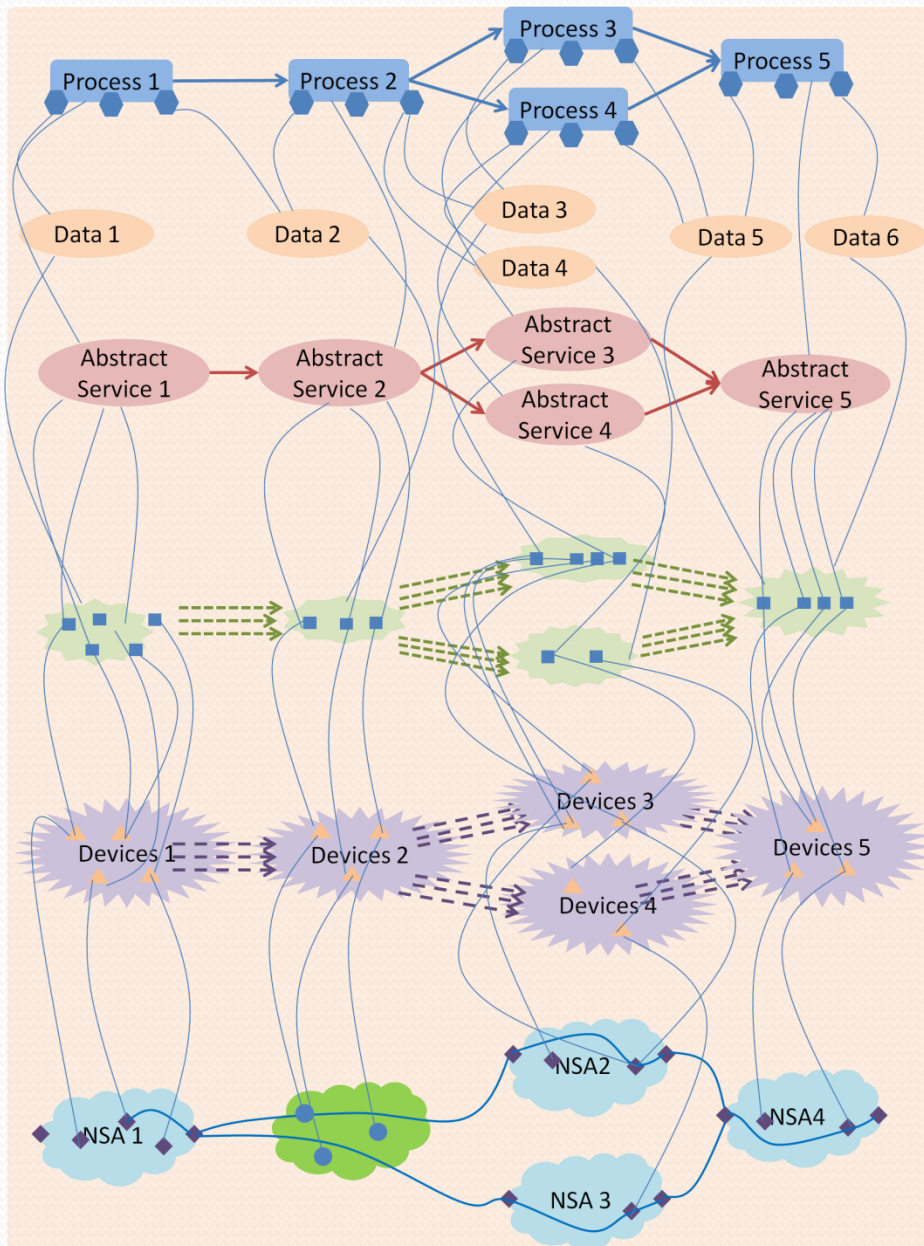


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# Background: e-Science and scientific workflow

- E-Science applications are characterized by
  - Massive data (acquiring and storing)
  - Intensive computing (Simulation, visualization and data processing)
  - Large scale collaboration (among processes, resources and domain scientists)
  - ...
- A workflow management system
  - Automates the execution of experiment processes
  - Controls the flow (data and control ) between processes
  - Allows scientists focus on experiments at different levels of abstractions
  - Hides the low level technical details from scientists
  - ...
  - Has been recognized as a core e-Science service.

# A layered view on workflow applications



**Abstract workflow descriptions (Requirements):** 1) abstract process (pre condition, exe condition, post condition), 2) process dependencies, 3) process flow

↕ Data requirement

**Data source description:** data constraints

↕ Functional requirements

**Data and abstract service descriptions:** select abstract services which implement the processes and meet the functional requirements

↕ Quality constraints

**Concrete service descriptions:** select instances of the abstract services which meet the quality constraints of Services and Data

↕ Physical locations

**Device descriptions:** select devices where the deployed concrete services can meet the quality constraints

↕ Network services constraints

**Network services:** select and reserve network connections that meet the workflow requirements

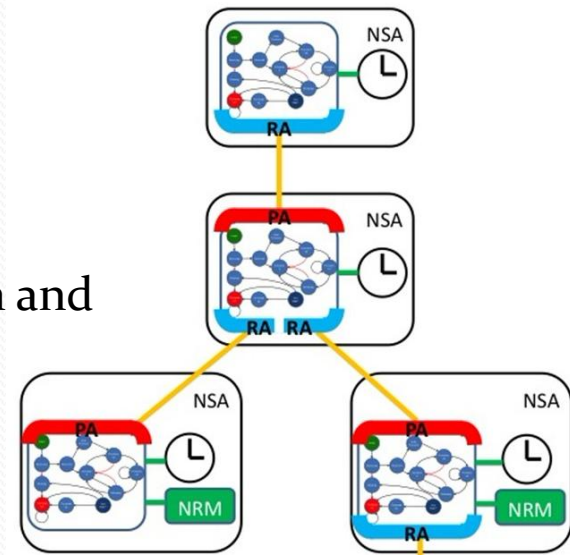
Network aware Workflow QoS Planner

# Outline

- Introduction: Network Service Interface (NSI)
- Problem description
- System design and prototype
- Performance characteristics
- Summary

# Network service interface (NSI)

- Background
  - Service interface for intra/inter domain reserving/ provisioning/ managing circuit network
  - NSI working group in OGF, 2008
  - The first NSI standard was released in 2011
  - Version 1, and 2
- Basic idea
  - Connections services for interfacing different types provisioning tools,
  - Define standardized information model for network topologies, namely Network Modeling Language (NML), based on the semantic web technologies
  - Provide agent based architecture for
    - Exchanging information of domain topologies,
    - Handling the network service selection, reservation and provision requests
    - Managing the state of a connection, such as reserve/scheduled/provision/cancelled/terminated



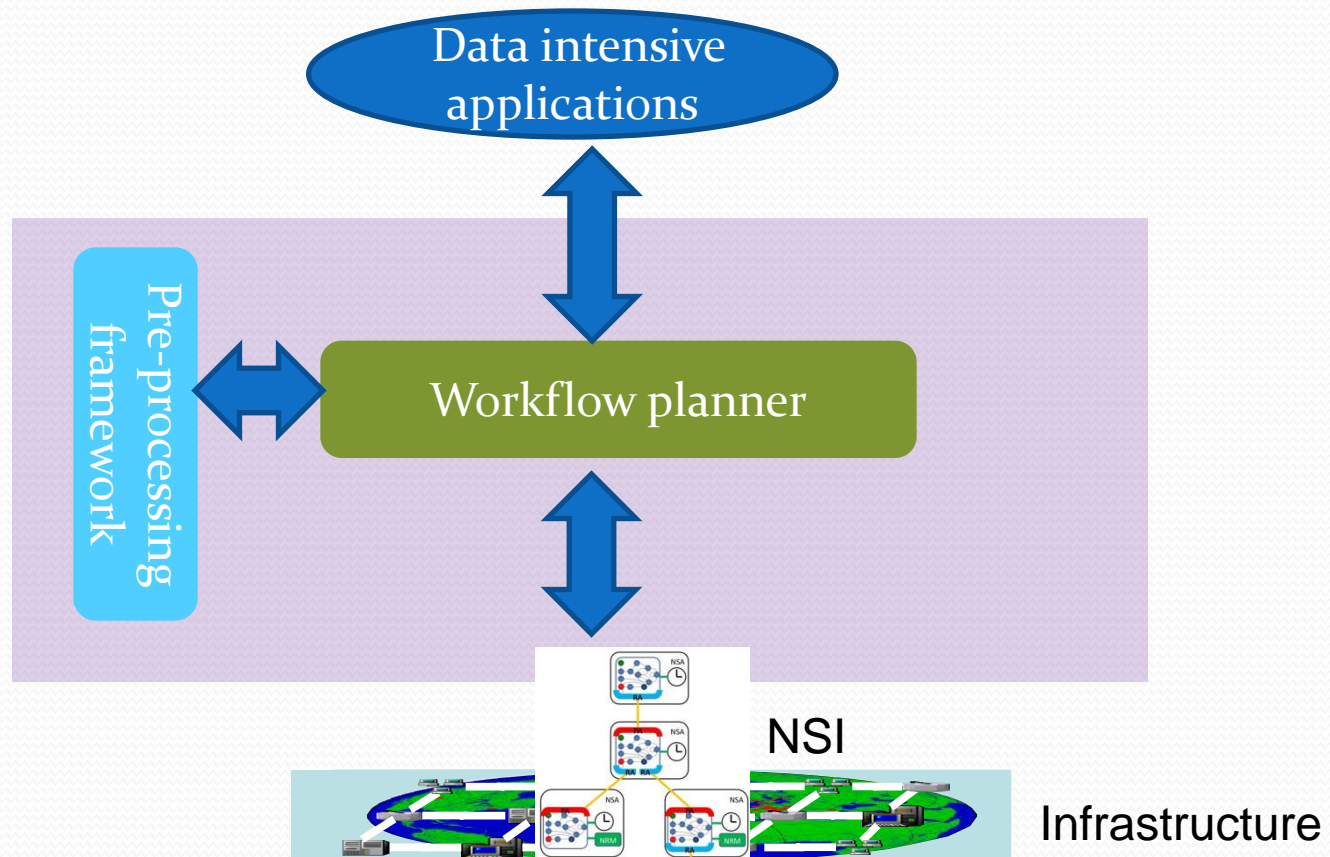
# Cont.

- Provides a web service based interface for clients or other NSAs to select and reserve network resources
- Network Service Termination Points (STP) indicate the resources which can be reserved by NSAs in a path.
- Cross domain reservations
  - a client only needs to know the start and end STP
  - Instead of knowing all the NSAs in a path,

# Mission

For large distributed e-Infrastructure and data intensive applications:

- What are the suitable composition, scheduling and execution model if network service interface are included in the workflow?
- How plan resource (including NSI) for abstract workflow?



# Requirement study

- We analyzed the requirements at each phase of the workflow lifecycle
  - using the Open Distributed Processing (ODP) method
  - Basically from its enterprise, information, computing, engineering, and technology viewpoints
- Some highlighted requirements (deliverable t3 to Dutch Surfnet)
  - The explicit description of NSA location and capabilities.
  - Reservation status of specific devices.
  - The explicit description of the NSA reservation policies.
  - Support for dynamic change of the reservations.
  - Combining with network monitoring information.



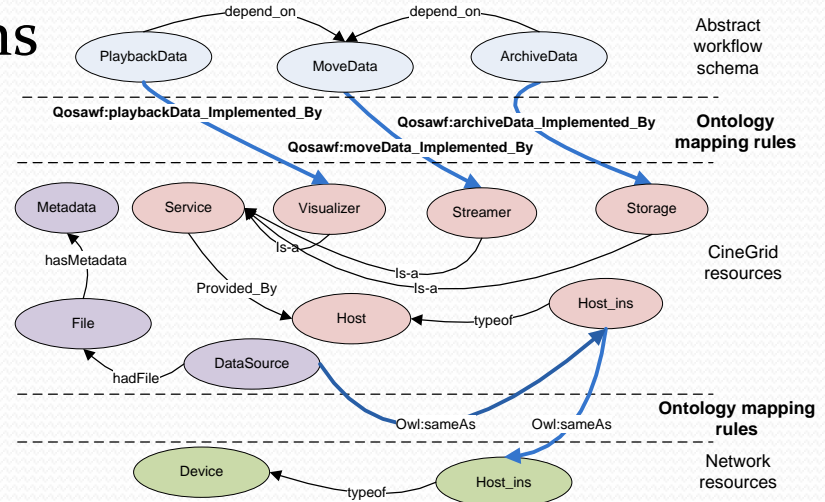
# System prototype using the current NSI

- In the context of Network aware Workflow QoS Planner (NEWQoSPlanner)
  - Information model mapping (Include NSI information model)
  - Resource selection
  - Resource reservation (Using the NSI)

# Description linking

- Stack of the resource descriptions

- Abstract workflow description (QoSAWF)
- Data content
- Services (CDL)
- Infrastructure (iNDL)
- Network / NSI (NDL/NML)



- Assumptions:

- Those descriptions are provided by different parties
- The files are not always well mapped and linked, preprocessing of the information is required

- Extend the NEWQoSPlanner

- NSI information model and the service description
- Resource selection and the NSI control

# Resource selection and reservation

- Resource selection
  - Parsing the abstract workflow, get constraint lists
  - Load resources and solve constraints
  - Select optimal resources from available candidates
    - For single process: search optimal  $(S, \text{path}(S, D), D)$  from  $\{\text{Source}\} \{\text{Destinations}\}$
    - For multi processes
      - $P_1(d_{11}, d_{12}), P_2(d_{12}, d_{22})$
      - $P_1(d_{11}, d_{12}), P_2(d_{21}, d_{22}), \rightarrow P_3(d_{12}, d_{21})$
      - Optimize paths in workflows
      - Get  $\{S\}, \{\text{Path}(S, D)\}, \{D\}$
- Reservation
  - Searching STP that link to the hosts for P, D

# Use case

Abstract workflow editor

newqosplanner-sc12.appspot.com/main/

Abstract workflow editor

New Load Template Save Template Upload Download Plan Help

Graph View OWL View

QoS AWF

- QoS AWF
  - DoS AWF2\_Thing
    - Constraint\_Thing
      - And\_Condition
      - Or\_Condition
      - Scope
    - Infrastructure\_Thing
      - Host
      - Infrastructure
      - Interface
      - Path
      - Service
    - Planning\_Thing
      - Request
      - Response
        - Candidate
        - Content
        - Property
        - Proposal
    - Provisioning Plan
    - QoS\_Thing
    - Quality\_Attribute
      - Precision
      - Codec Quality
      - Compression Rate
      - Resolution
        - ResolutionX
        - ResolutionY
      - Reliability
        - ErrorRate
      - Security\_Level
      - Timeliness

```
graph TD; Request[Request] -- require_Functionality --- PlaybackData[Playback Data]; PlaybackData -- pre_Condition --- Or_Condition1[Or_Condition]; PlaybackData -- execution_Condition --- Or_Condition2[Or_Condition]; Or_Condition1 -- contain_Condition --- And_Condition1[And_Condition]; Or_Condition2 -- contain_Condition --- And_Condition2[And_Condition]; And_Condition1 -- require --- Media[Media]; And_Condition2 -- require --- Media; Media -- require_Quality --- ResolutionY[ResolutionY]; Media -- require_Quality --- ResolutionX[ResolutionX]; And_Condition2 -- require_Quality --- Framerate[Framerate];
```

# Use case (2)

newqosplanner-sc12.appspot.com/rest/execute/monitor/2f9f66a5-7cdb-4

Thumbnail	Description	Author	File Size	Codecs	Resolution
	A recording of "Era la Notte" at the Holland Festival	CineGrid	2147483647	dxt	4096x2160
	A recording of "Era la Notte" at the Holland Festival	Cinegrid	2147483647	dxt	4096x2160
	A recording of "Era la Notte" at the Holland Festival	CineGrid	2147483647	dxt	4096x2160

Type	Host
Destination	http://cgdev.uvalight.nl/arie/owl/uvalight-sc12.owl#Booth_mac
Source	http://cgdev.uvalight.nl/arie/owl/uvalight-sc12.owl#h1.wf.vlan400.uvalight.net

## Available Paths

Name	Bandwidth	QualityRank	Capability	Reserve	Execution
	10	1	<input type="button" value="Capability"/>	<input type="button" value="Reserve"/>	<input type="button" value="Execute"/>

## Path details

No.	Host	Interface
3	http://cgdev.uvalight.nl/arie/owl/uvalight-sc12.owl#Booth_mac	http://cgdev
2	http://cgdev.uvalight.nl/arie/owl/uvalight-sc12.owl#ndl.Force10.uvalight.nl	http://cgdev
1	http://cgdev.uvalight.nl/arie/owl/uvalight-sc12.owl#ndl.Force10.uvalight.nl	http://cgdev

newqosplanner-sc12.appspot.com/rest/execute/monitor/2f9f66a5-7cdb-4aff-b

Discovered candidates Execution Log

### Log Console

151335ms (+1) 3:29:51 AM NSA Reservation

Source STP: 'uvawf.ets:forcel0\_h1'

151334ms (+1) 3:29:51 AM NSA Reservation

Source NSA Provider: uvalight

151333ms (+0) 3:29:51 AM NSA Reservation

Source NSA: 'http://h0.wf.vlan400.uvalight.net:9080/NSI/services/ConnectionService'

151333ms (+1) 3:29:51 AM NSA Reservation

Source bandwidth: 10

151332ms (+0) 3:29:51 AM NSA Reservation

Destination STP: 'uvawf.ets:forcel0\_h5'

151332ms (+0) 3:29:51 AM NSA Reservation

Destination NSA Provider: uvalight

151322ms (+1) 3:29:51 AM NSA Reservation

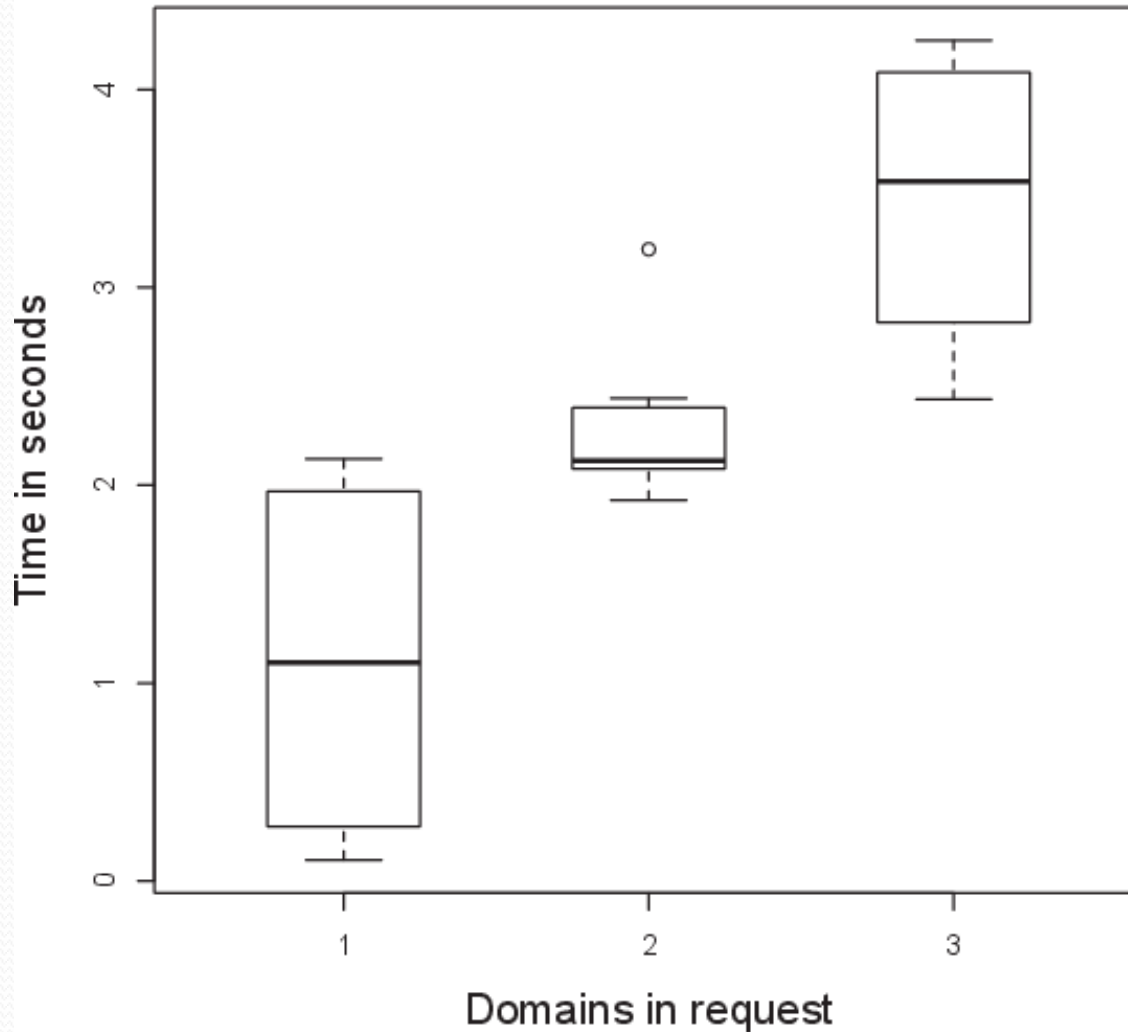
Pause

### Reserve NSA

Start Time

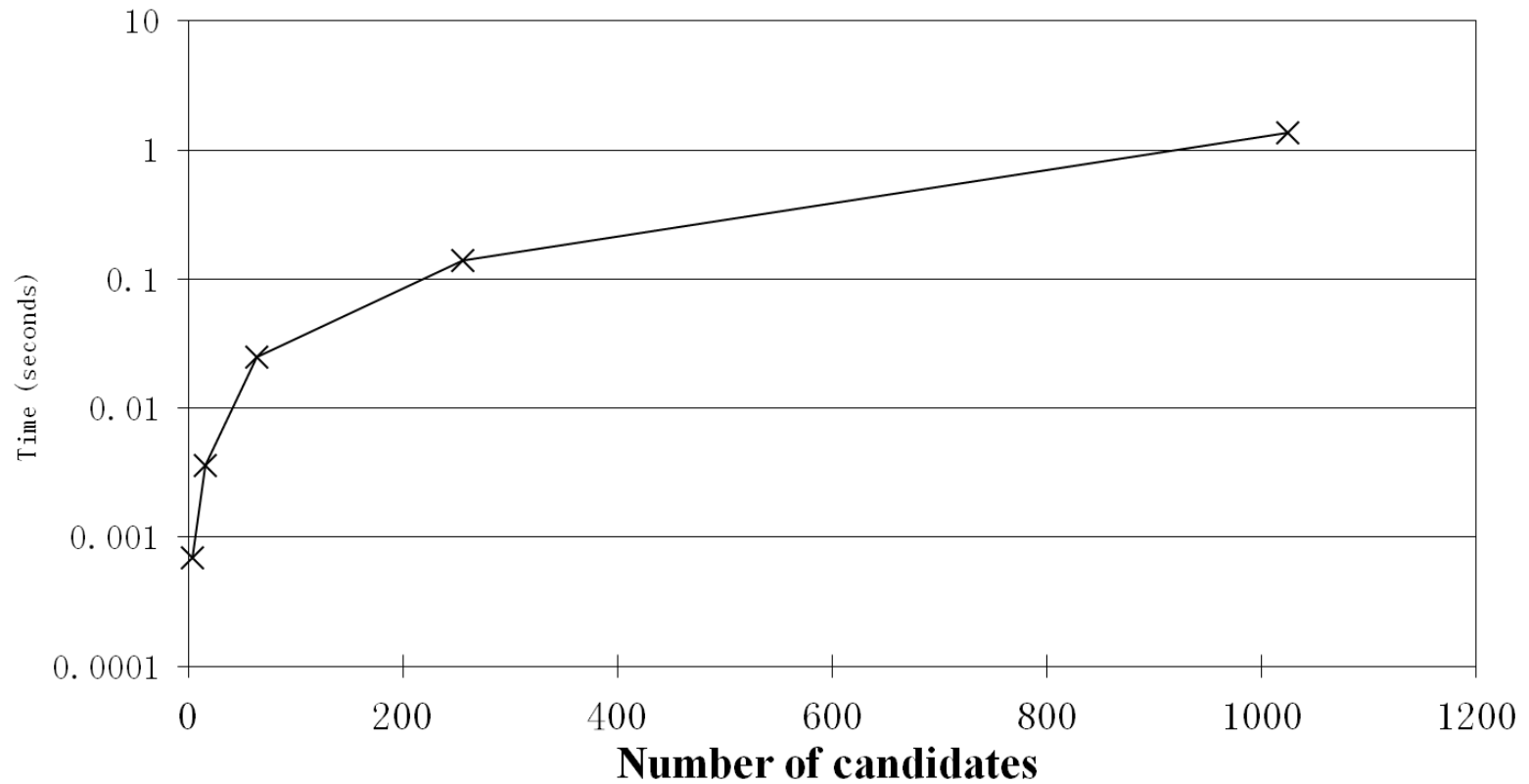
Stop Time

# Performance characteristics



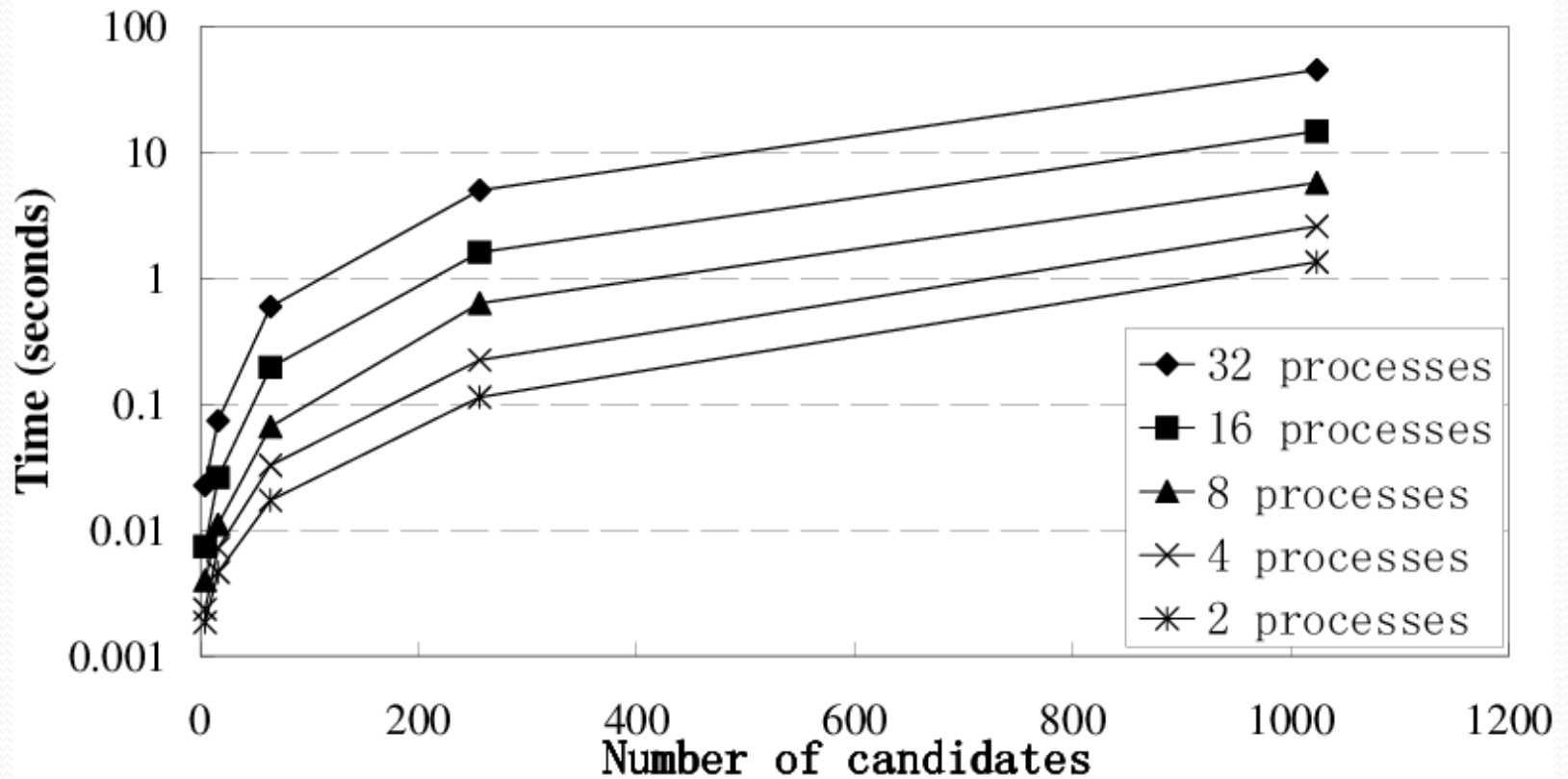
# Cont.

## Time cost for single process workflow



# Cont.

## Time cost for different size workflows





# Summary

- In this paper, we presented our ongoing work on network control for supporting data intensive applications.
- We argued that the NEWQoSPlanner provides agents for searching suitable network resources and is towards the direction of network quality adaptive planner workflow processes, and it can only be effective for data intensive applications when the actual provisioning and control of the service quality can be included.
- With the standardized network control interface, applications are able to include the network QoS control in the composition and execution.

# Future directions

- First, the monitoring and logging of the network events to allow the infrastructure provider to study the network dynamics in the context of applications for optimizing the services delivery.
- Second, the workflow execution time will be included in the reservation to make the advanced reservation more flexible.
- Third, interoperability between NSI and other programmable network infrastructure, such as OpenFlow.

# Reference

- Acknowledgement



- Live demo is in the Dutch booth 2333 @ SC12
- Portal interface
  - <http://newqosplanner-sc12.appspot.com/main/>
- Project page
  - <http://staff.science.uva.nl/~zhiming>