System and Network Engineering MSc
Research project

PIRE ExoGENI – ENVRI preparation for Big Data science

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Background

Big Data science

- Huge amount of data
  - Many sources
- Data Movement (DM) is very important
- Described by “5V”s (Volume, Velocity, Variety, Variability and Value)

Software Defined Networking (SDN)

- Separate control plane from data plane
- Single entity controls the network
- Forwarding intelligence relies on programmers

Research questions

The main research question is the following:

- *To what degree can the performance of the data movement protocols be optimized by using Software Defined Networking technology?*

The main research question includes the following sub-questions:

- *What network level problems exist which limit the performance of the data movement protocols?*
- *How can SDN eliminate these problems?*

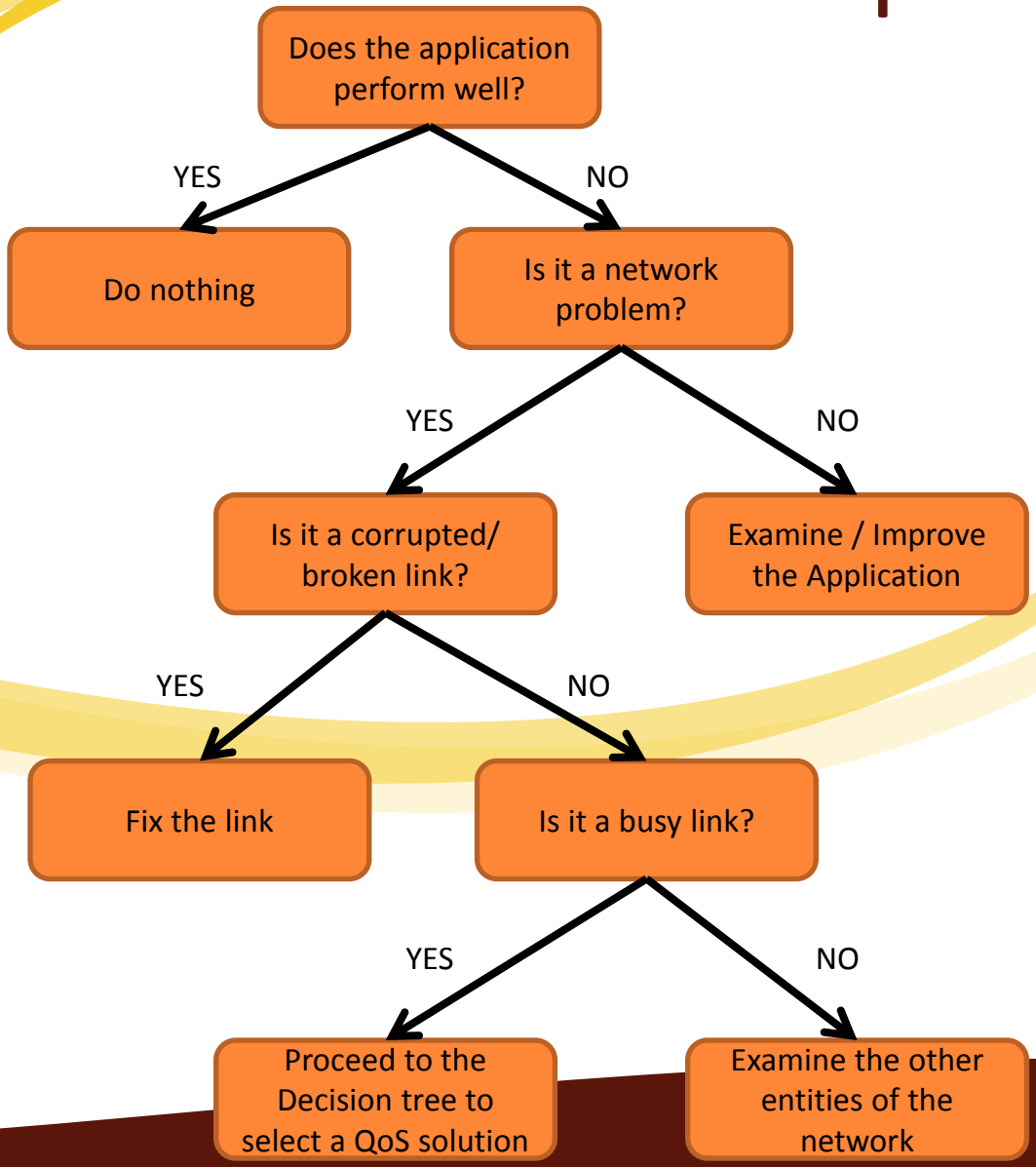
Outline

- Theory part
  - *Problem analysis*
  - *Solution profiles*
- Experimental part
  - *Prototyping HIDE (Hybrid Intelligent Data Enhancer)*
  - *Scenarios and Results*
- Conclusion

Data Movement Application problems

Application	Positives	Negatives	Network limits
GridFTP (Globus)	-Open source -High scalability -High reliability -Option to resume transfers that are stopped because of failures	-Difficult to deploy -Network speed limit: (13 Gbps for TCP version)	-Decrease window size for every loss packet and resend the packet -Application is not aware for the topology and the path that data flows -Most of times the speed of transferring data is limited due to network traffic
bbFTP (NASA)	-Open source -High scalability -High reliability -Multi-stream TCP -Easy to deploy -Resume file transfer session	-Transfer only files, not directories -Little industry adoption -Little documentation	
FDT (CERN)	-Open source -Runs on all major platforms (Java application) -Multi-stream TCP -Resume file transfer session	-Little industry adoption -Little documentation -Network speed limit (4.5 Gbps)	

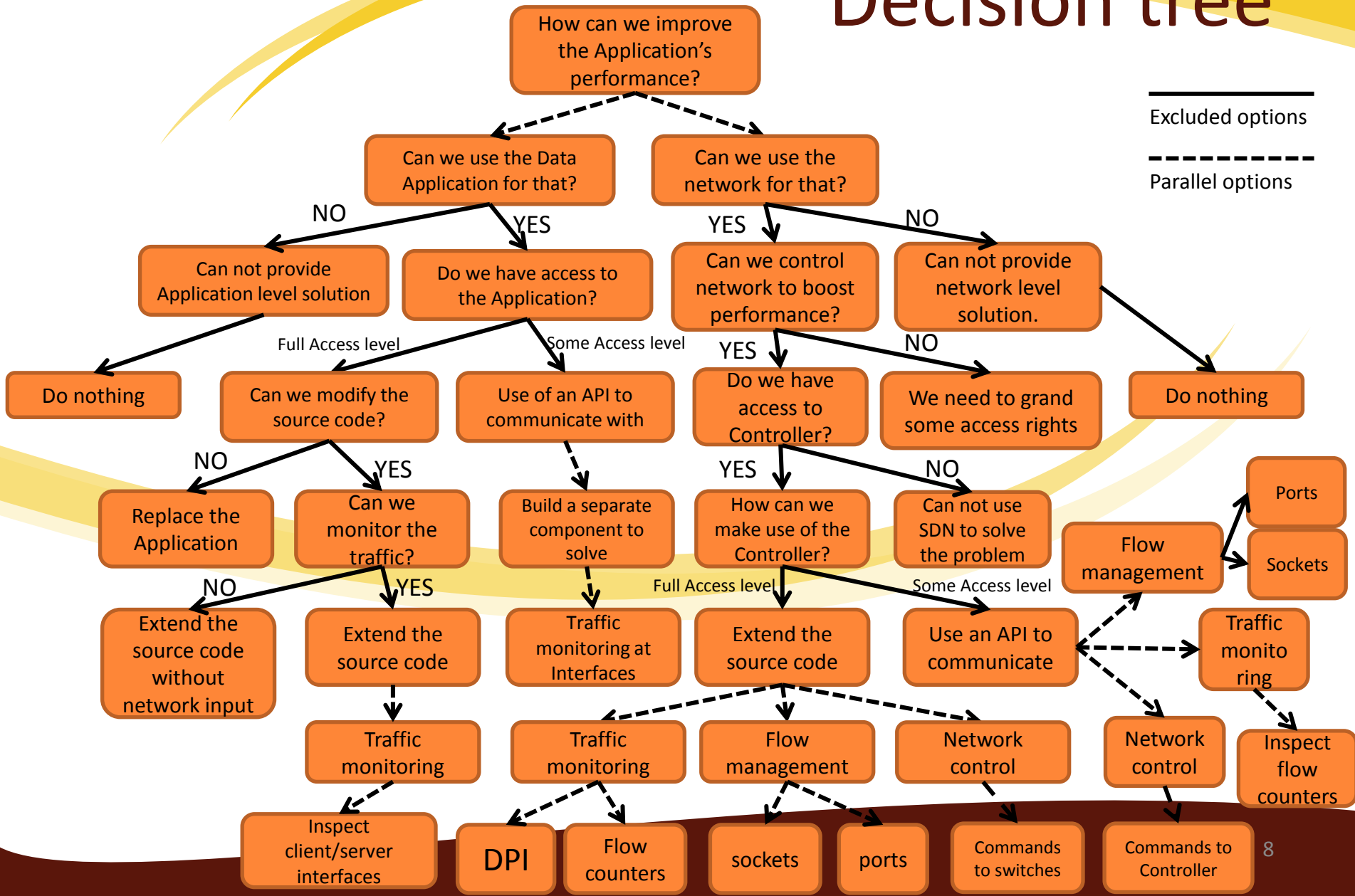
Performance problem?



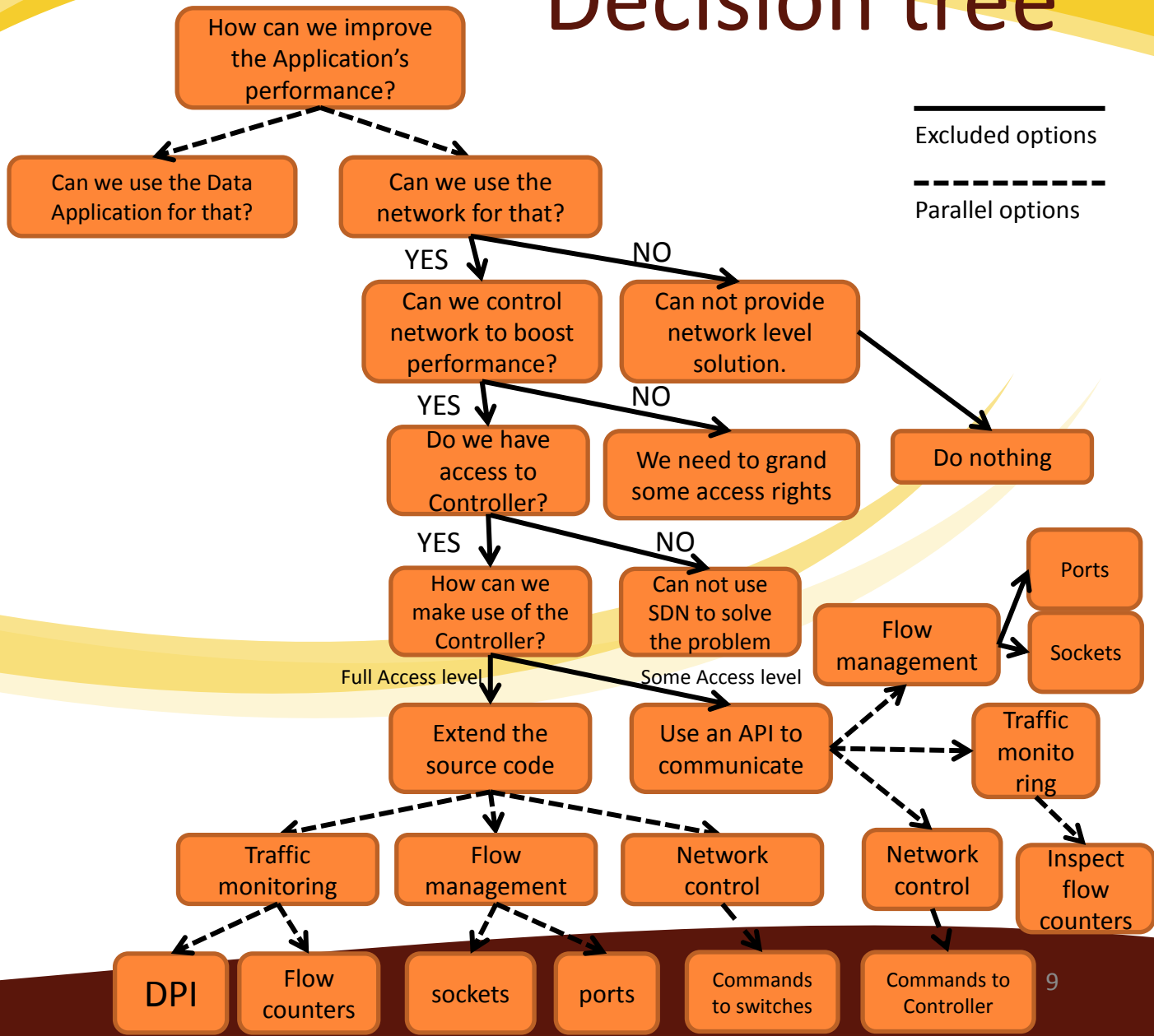
Available technologies

- Traffic monitoring
  - *Deep Packet Inspection (DPI)*
  - *Inspect client/server interfaces*
  - *Inspect flow counters*
- Flow management
  - *Port level*
  - *Socket level (IP address and TCP port)*
- Network Controllability
  - *Commands to the controller (API)*
  - *Commands to the switches*

Decision tree



Decision tree



Decision tree

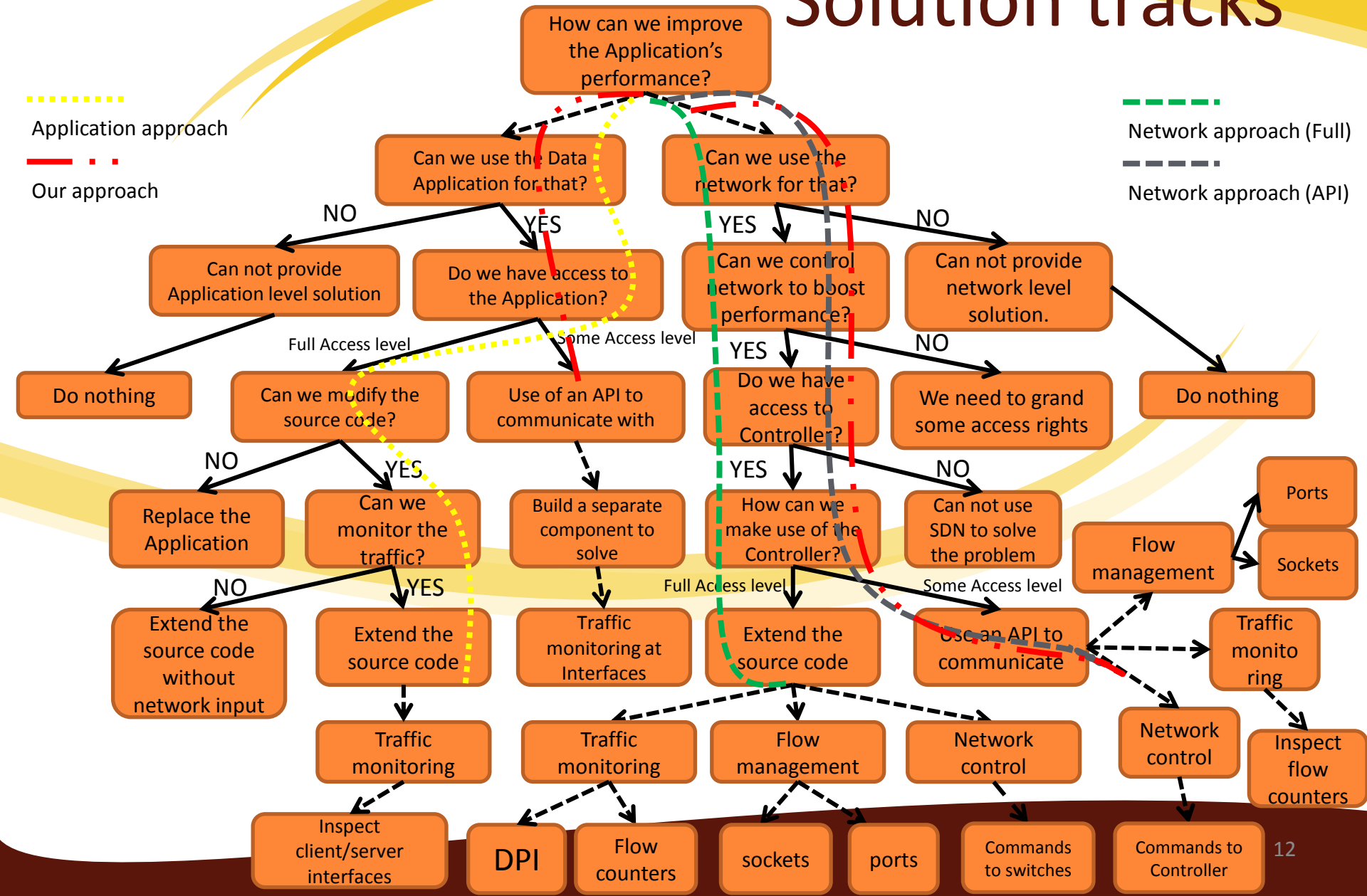
Excluded options

Parallel options

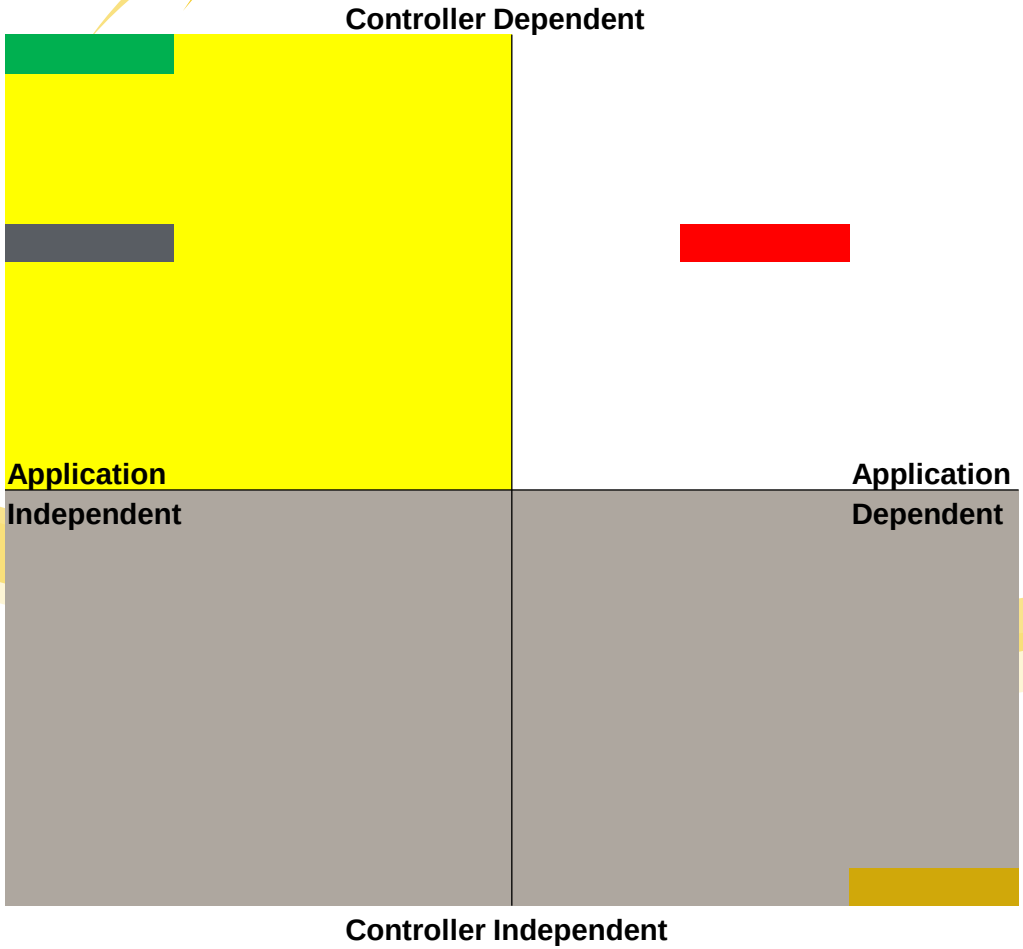
Solution development profiles

Requirements	Application level Programmer	Network Programmer (API)	Network Programmer (full)	Hybrid Programming
Develop at Application level	**YES**	NO	NO	**YES**
Develop at Network level	NO	**YES**	**YES**	NO
Make use of SDN Technology	NO	**YES**	**YES**	**YES**
Access to the Application	**YES**	NO	NO	**SOME**
Access to the Controller	NO	**SOME**	**YES**	**SOME**
Network topology knowledge	NO	**YES**	**YES**	**YES**
Network status knowledge	**SOME**	**YES**	**YES**	**YES**
Traffic monitor using DPI	NO	NO	**YES**	NO
Traffic monitor on flow level	NO	**YES**	**YES**	**YES**
Traffic monitor at Interfaces	**YES**	NO	NO	NO
Flow management	NO	**YES**	**YES**	**YES**
Network controllability	NO	**SOME**	**YES**	**YES**

Solution tracks



Controller-Application relationship



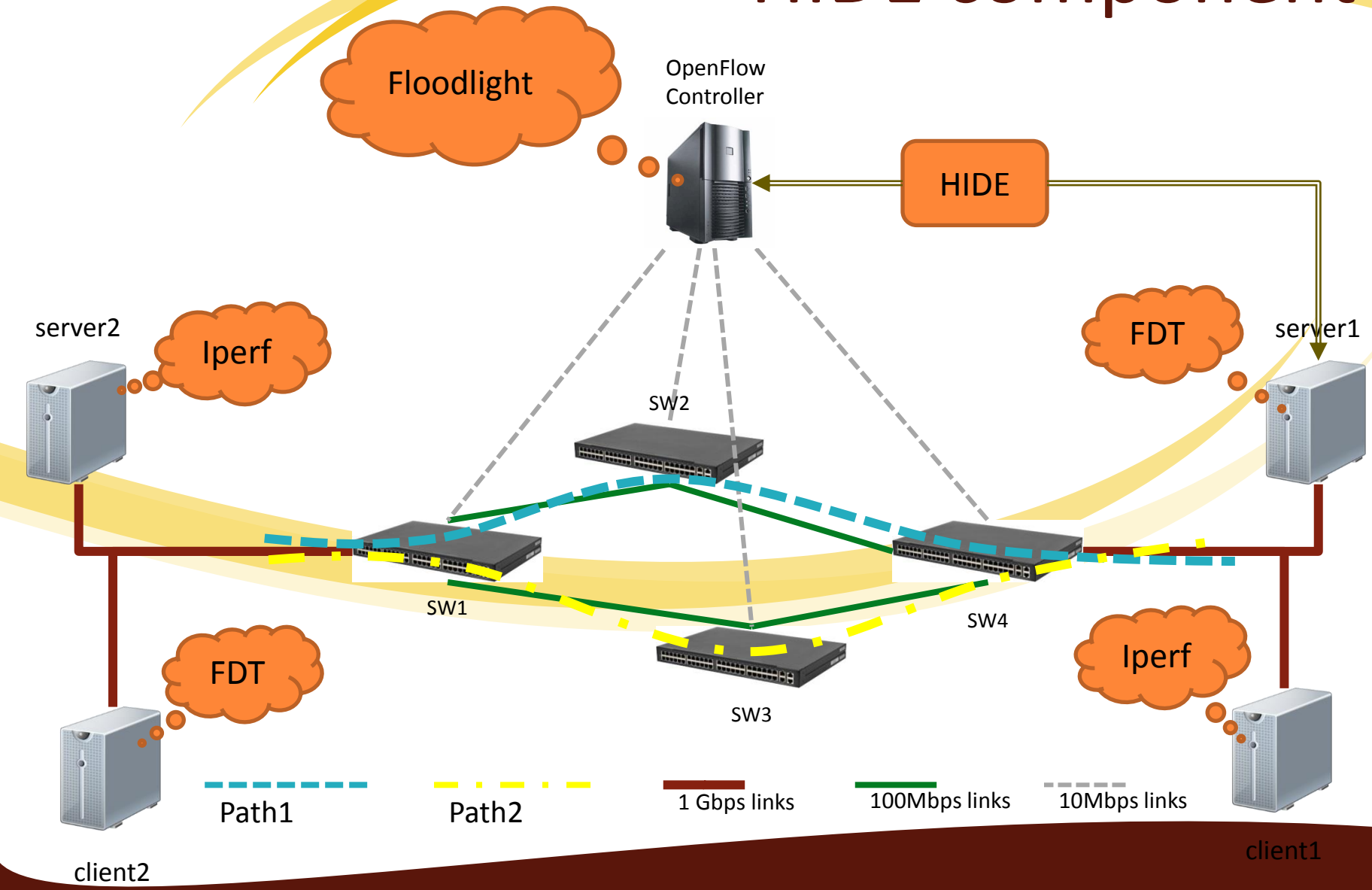
Our approach

Network level

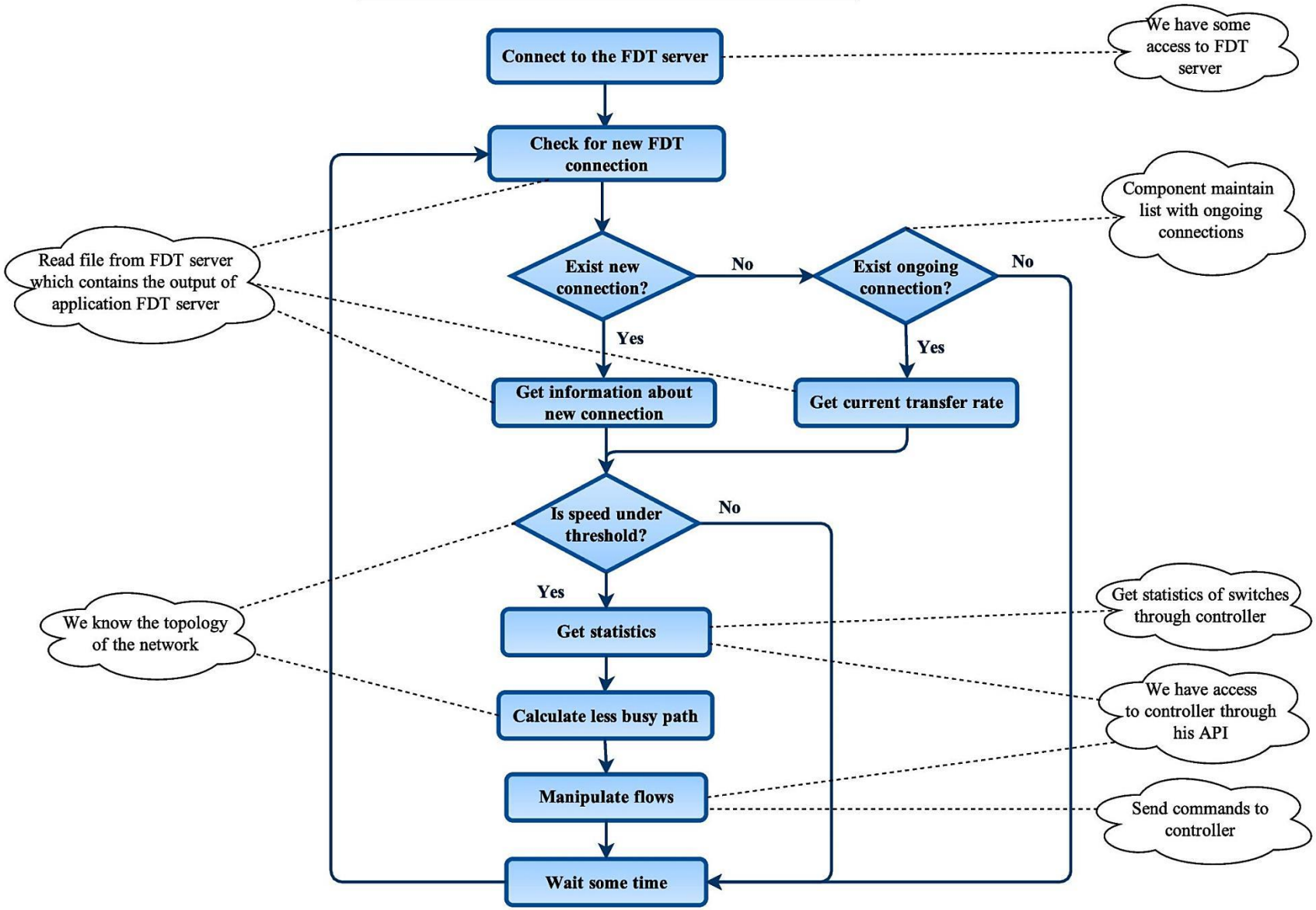
Network level (API)

Application level

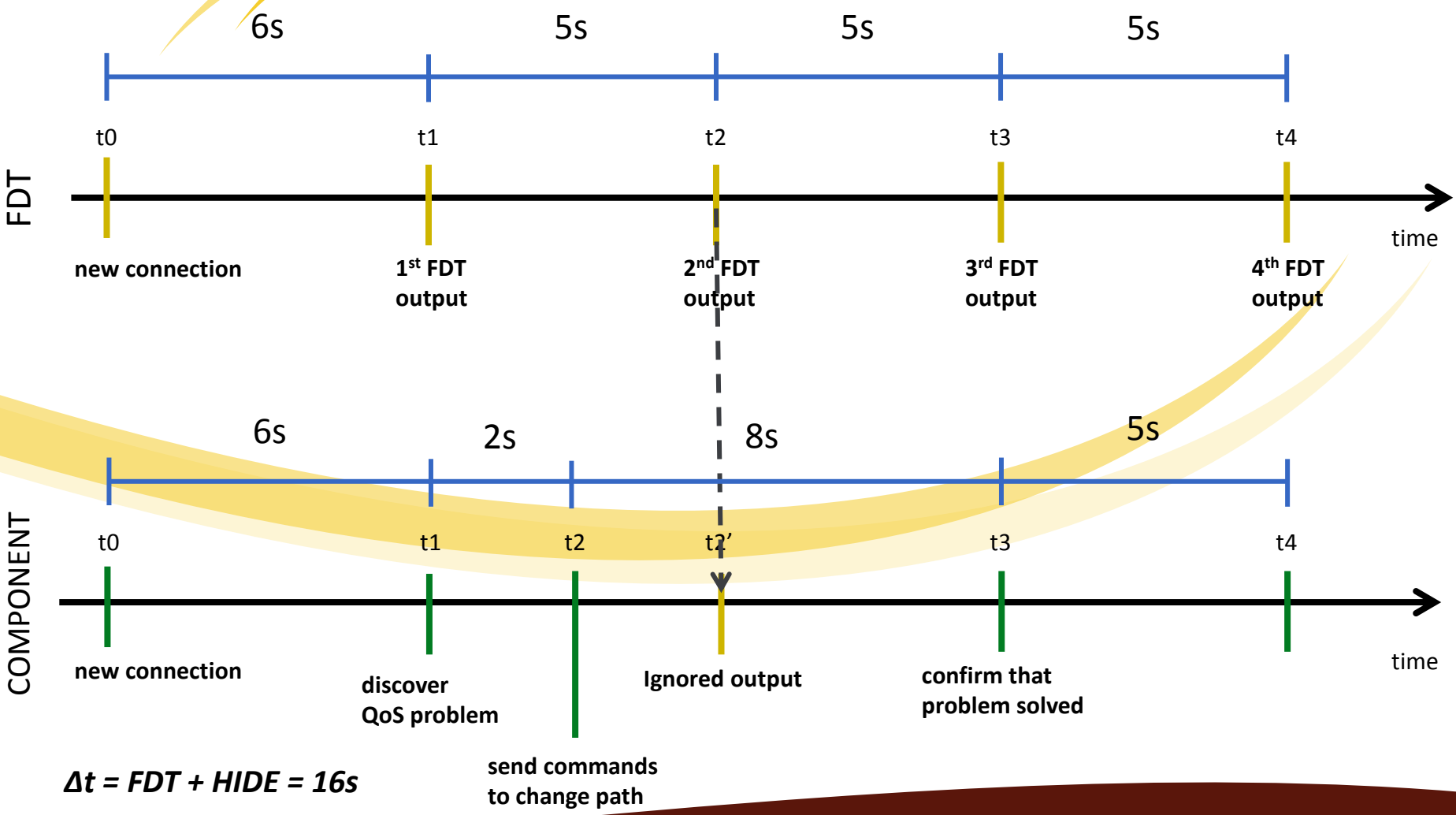
HIDE component



Component's Algorithm



HIDE overhead

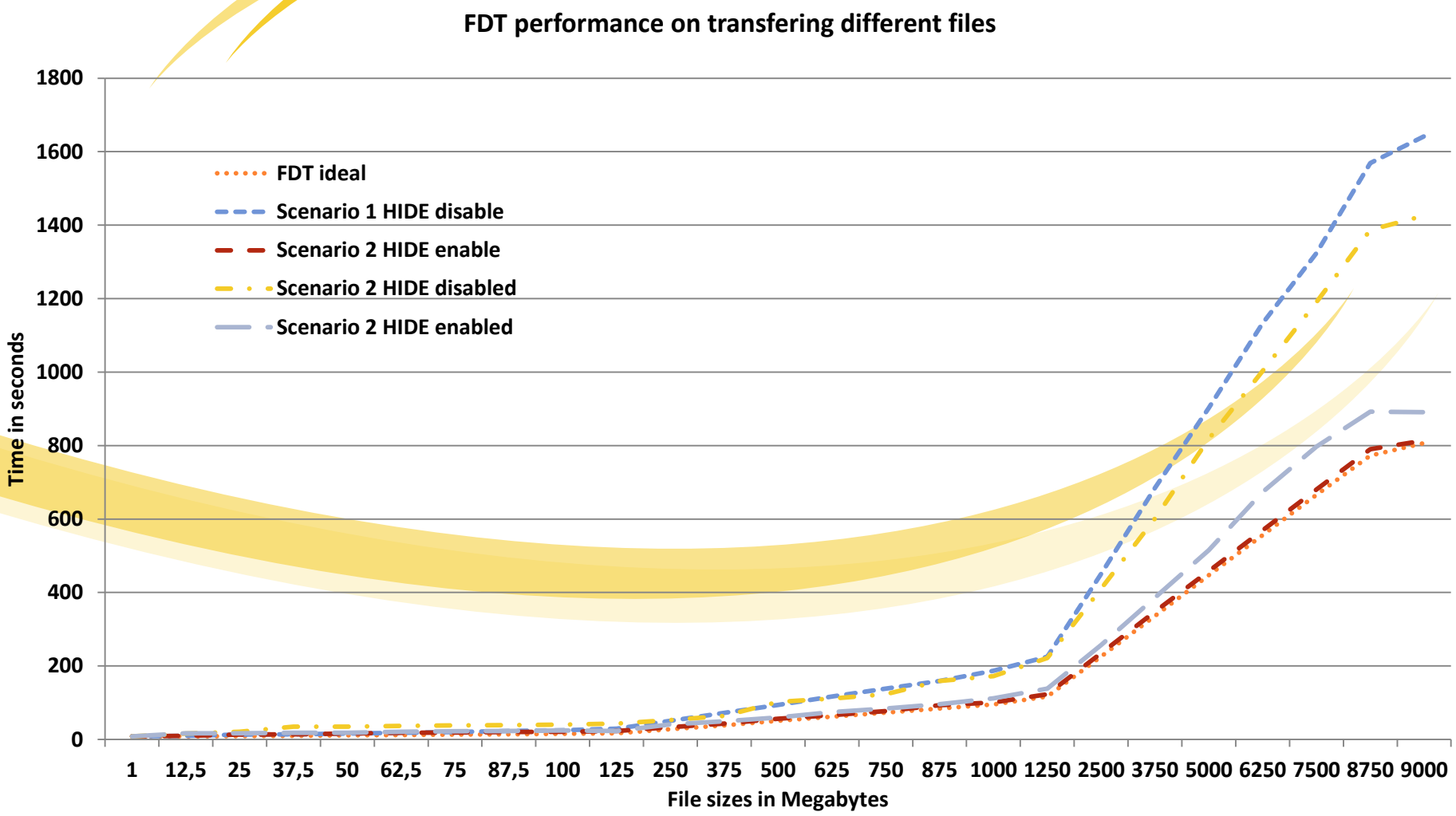


Δt = FDT + HIDE = 16s

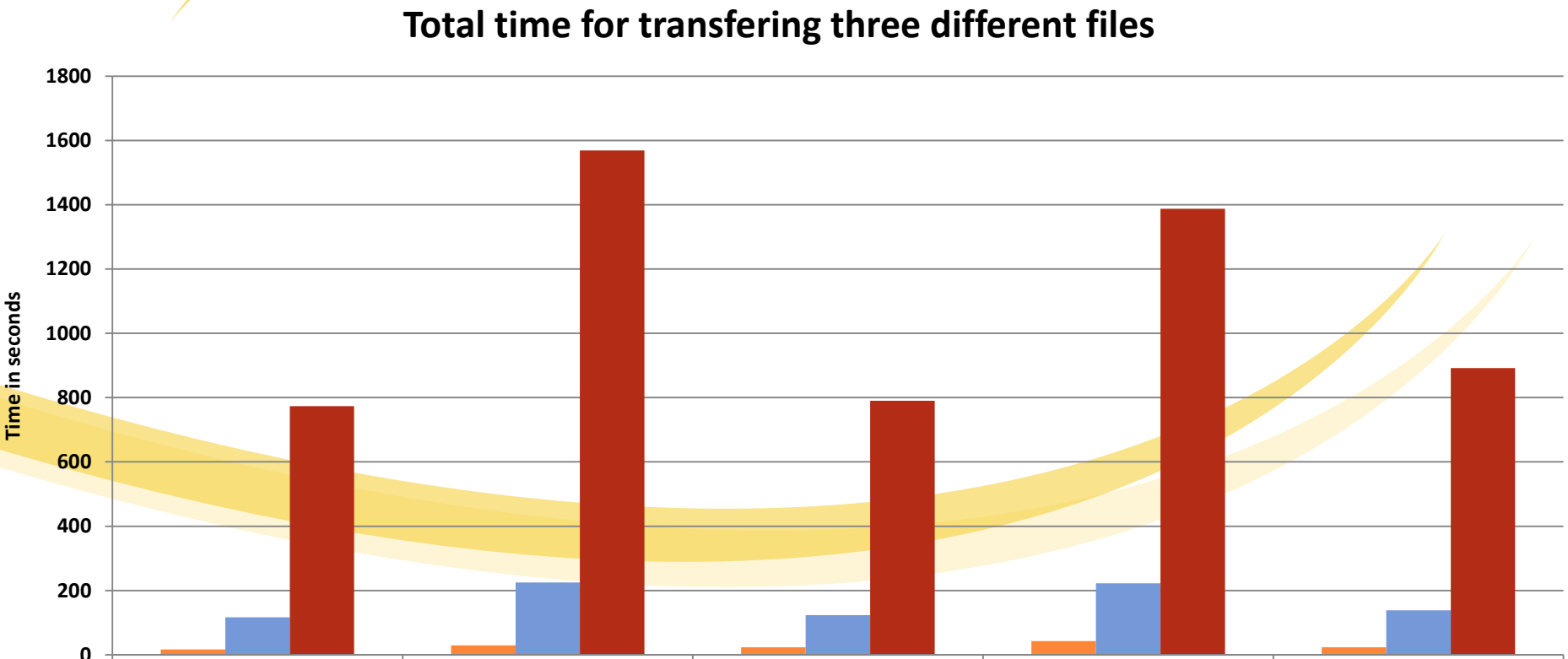
Scenarios

- Scenario 1
  - Transferring files via Path1 with and without interfering traffic for getting reference points
- Scenario 2
  - Transferring files via Path1 with interfering traffic and component enabled
- Scenario 3
  - Interfering traffic change path every 30s in order to stress HIDE for longer period

Scenario results

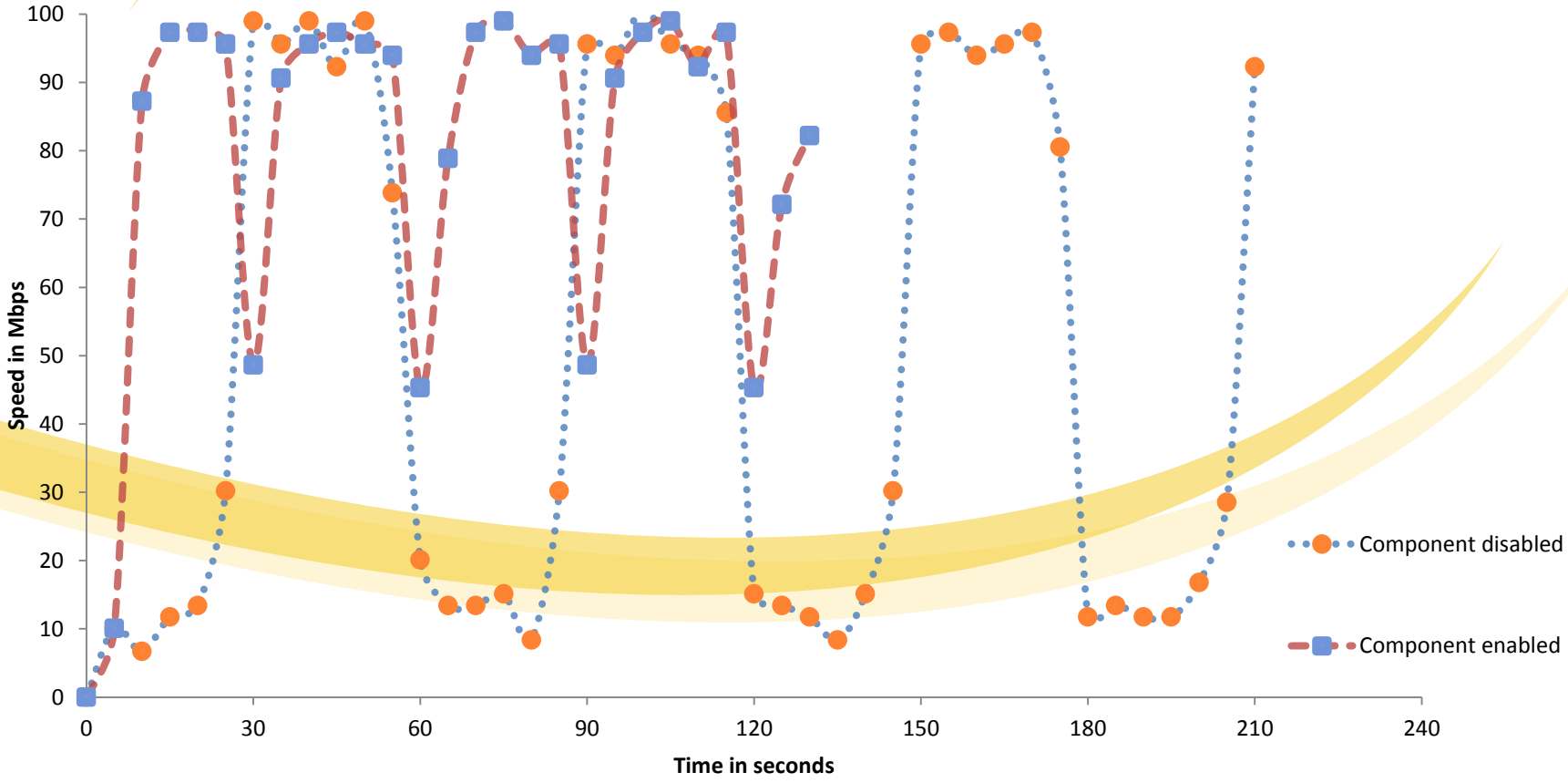


Total transfer time



	Scenario 1	Scenario 2 HIDE disabled	Scenario 2 HIDE enabled	Scenario 3 HIDE disabled	Scenario 3 HIDE enabled
125 MB	17	29	23	43	23
1.25 GB	117	225	123	222	138
8.75 GB	773	1569	790	1387	892

Representative sample of Scenario 3



File size 1.25Gb

Data points every 5s

Discussion

- ✓ Adequate level of abstraction and portability
- ✓ Using SDN to enhance data movement
- ✓ Intelligence based on real time input

- — Lower bound of reaction time depended on FDT server
- — Topology knowledge should be requested from controller

Conclusion

- Data Movement Applications can gain benefits from SDN
- Through the mentioned degrees of solving the QoS problem we touched one and it was successful
- ExoGENI is well designed environment to deploy topologies and perform experiments

Future work

- Reduce reaction time
  (highly depended on FDT)
- Improve intelligence
  (get topology knowledge from controller)
- Investigate a prediction algorithm
  (avoid network overload)

Thank you

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