PhantomNet

An end-to-end mobile network testbed

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Why another mobile network testbed?

- Mobile networking growing traffic-wise and growing in importance
  - Mobile devices increasing in sophistication and becoming the "compute platform of choice"
- Current network architectures (LTE/EPC) are packet based
  - But under the hood look a lot like their circuit switched forebears
- Major technology trends reshaping the way we do things
  - Cloud computing, software defined networking, network function virtualization
- Current measurement studies
  - From the "outside", no ground truth

Need a realistic "playground" where as a community we can:

- **explore/invent mobile network architectures in an end-to-end manner**
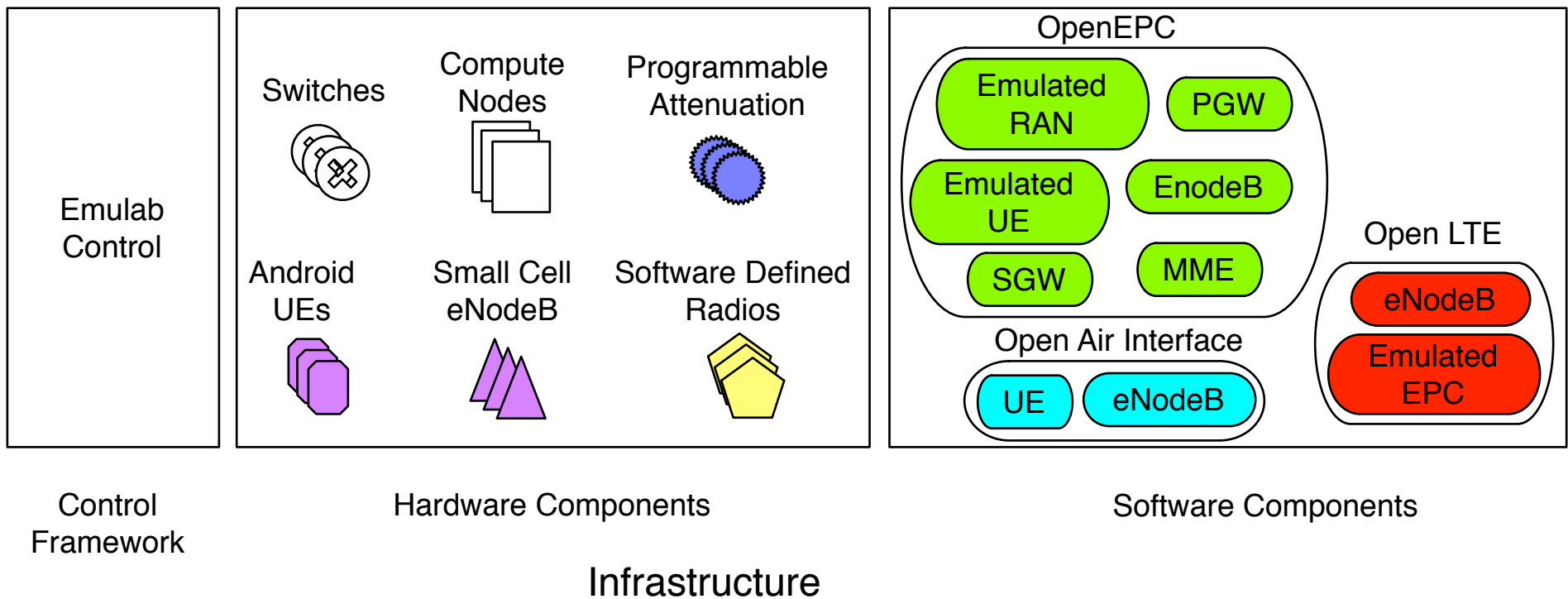- **look "under the hood" of existing mobile network architectures**

PhantomNet

Programmable end-to-end mobile testbed to enable research at the intersection of mobile networking, cloud computing and software defined networking

- Diverse mix of hardware and software resources
- Remotely accessible and sharable (time and space)
  - Emulab style
- Enables end-to-end mobile networking research
  - Endpoints
  - Radio Access Network (RAN)
  - Mobile Core Network
  - Cloud
 - Software Defined Networking (SDN)

What does PhantomNet give you?

Diverse mix of hardware and software resources

Emulab Control

Control Framework

Hardware Components:
Switches, Compute Nodes, Programmable Attenuation, Android UEs, Small Cell eNodeB, Software Defined Radios

Software Components:
OpenEPC — Emulated RAN, PGW, Emulated UE, EnodeB, SGW, MME
Open Air Interface — UE, eNodeB
Open LTE — eNodeB, Emulated EPC

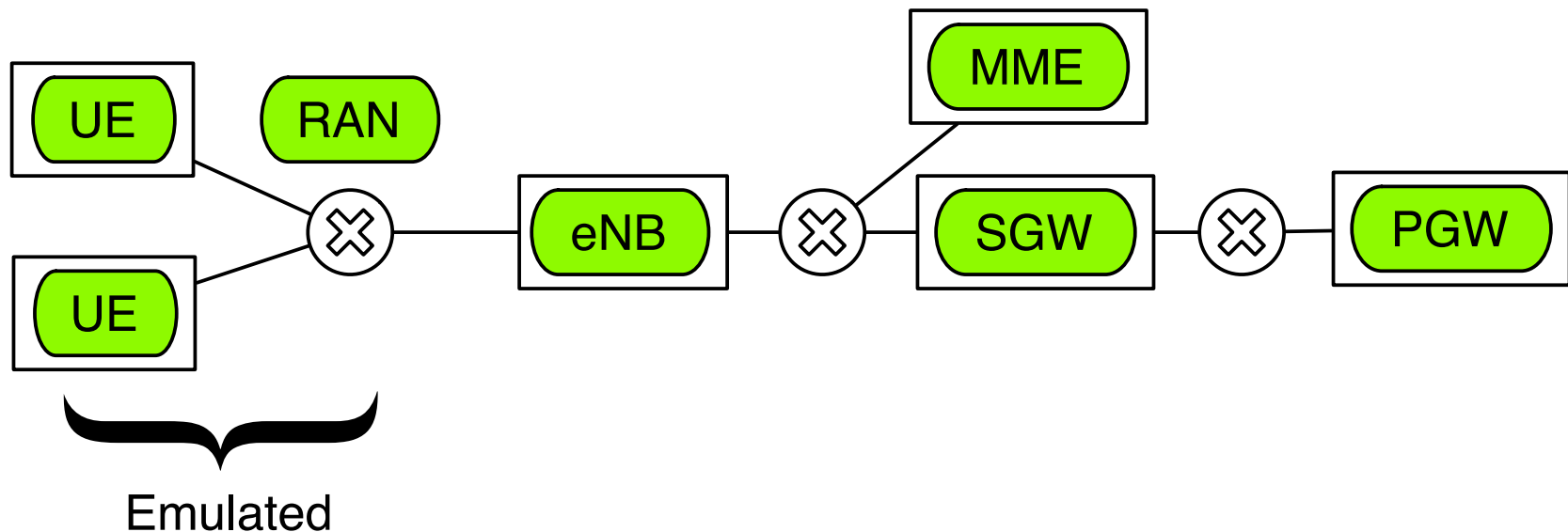Infrastructure

How do you use PhantomNet?

- Users request hardware and software resources for their experiment
- Emulab control framework allocates and instantiates
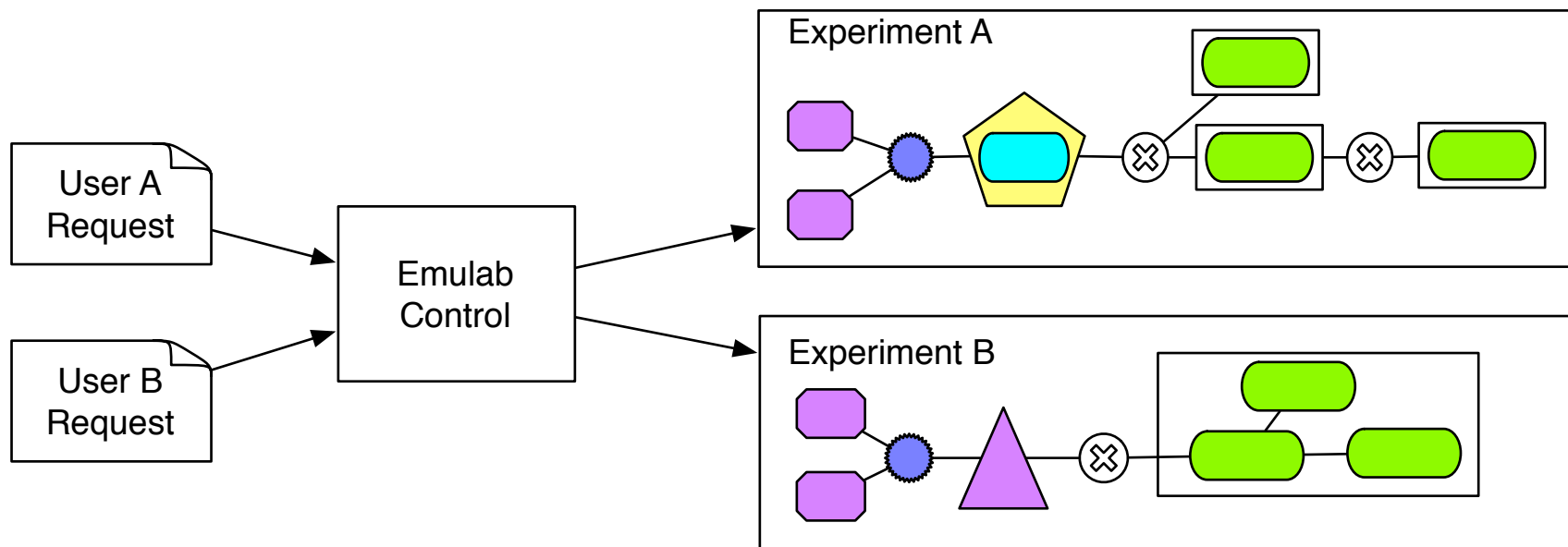
Workflow

What can you do with PhantomNet?

- Evolved packet core (EPC) with OpenEPC components
- Core elements: physical or virtual machines
- Emulated RAN

Emulated

What can you do with PhantomNet?

- Evolved packet core (EPC) with OpenEPC components
- Real RAN:
  - Off-the-shelf user equipment (UE) (Android devices)
  - Off-the-shelf base station (eNodeB) (ip.access small cell)
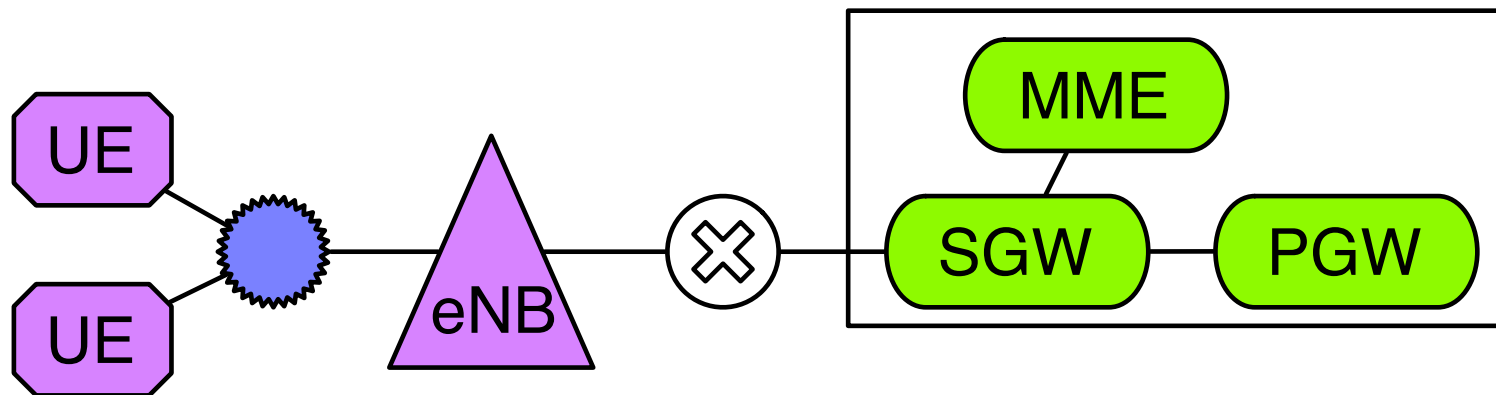
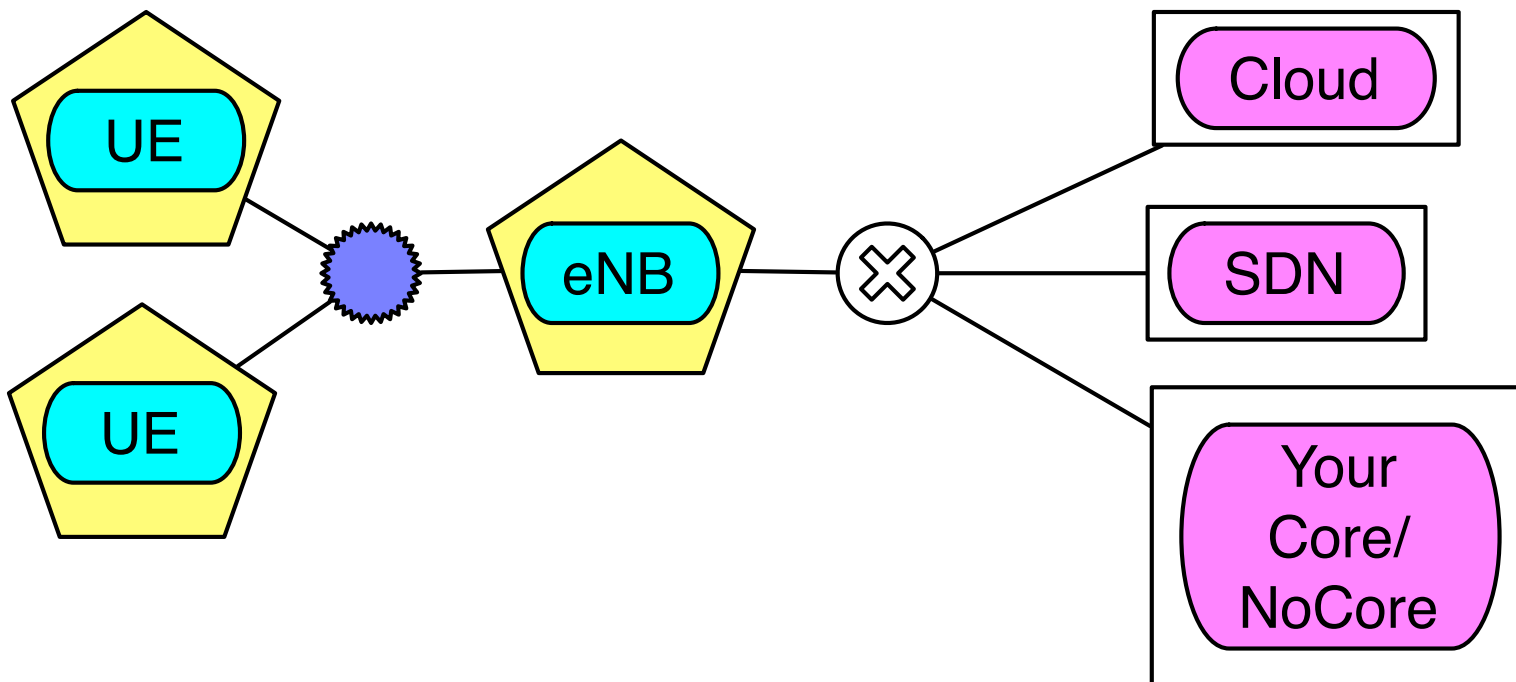# What can you do with PhantomNet?

- Evolved packet core (EPC) with OpenEPC components
- Real RAN:
  - Off-the-shelf user equipment (UE) (Android devices)
  - SDR-based UE (USRP with OAI)
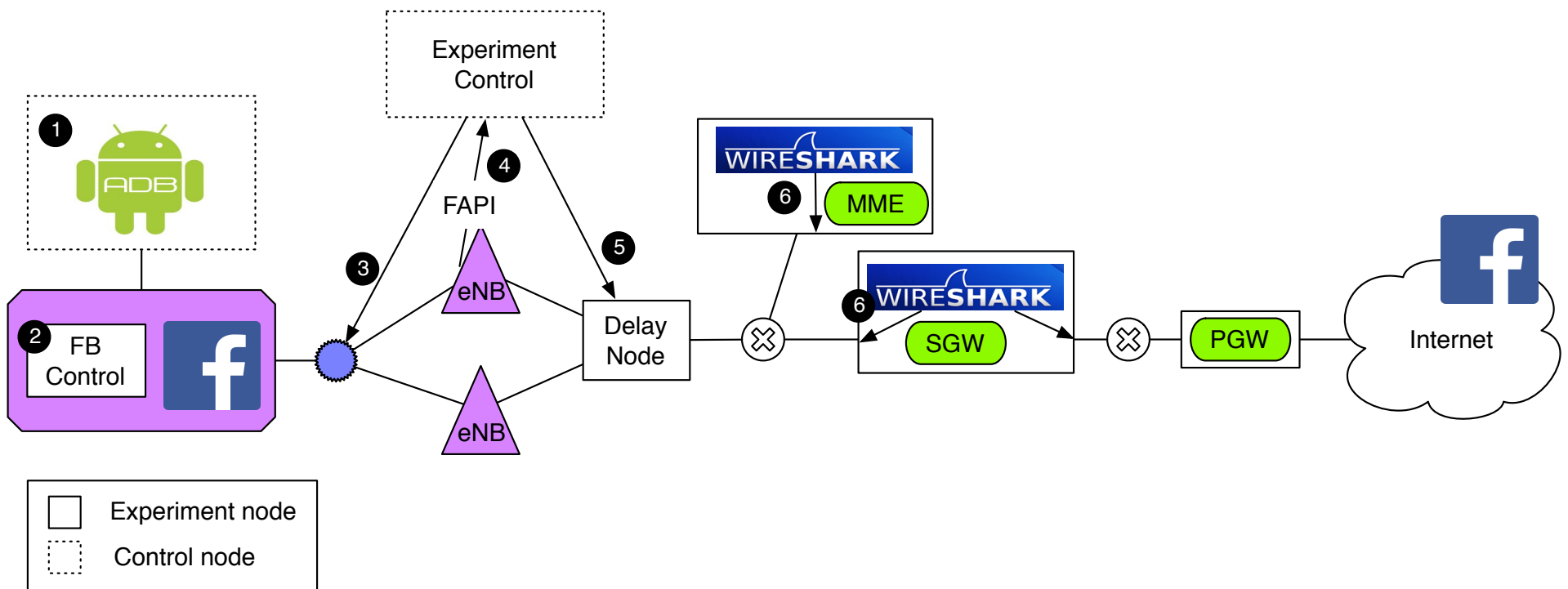 - SDR-based base station (eNodeb) (USRP with OAI)
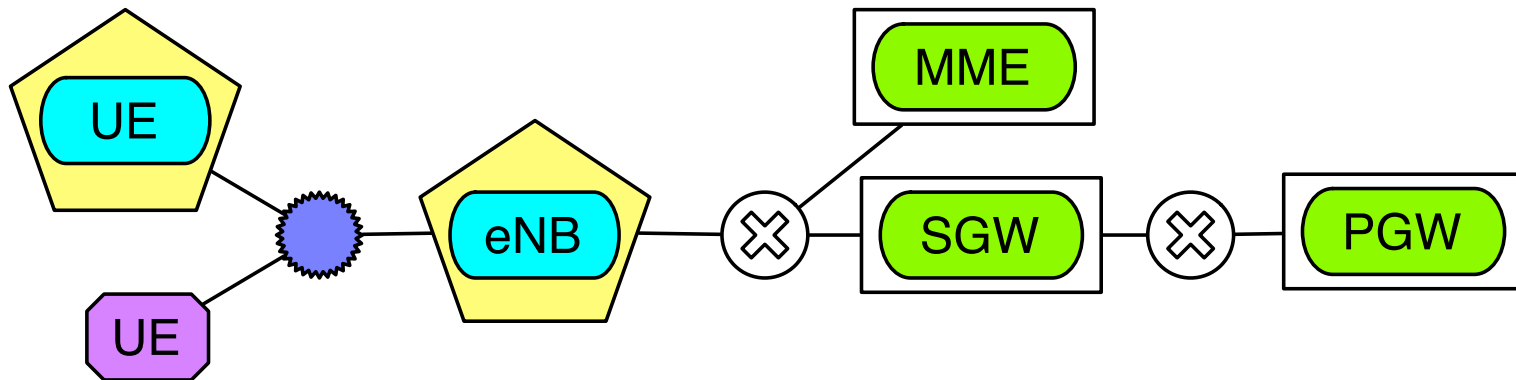
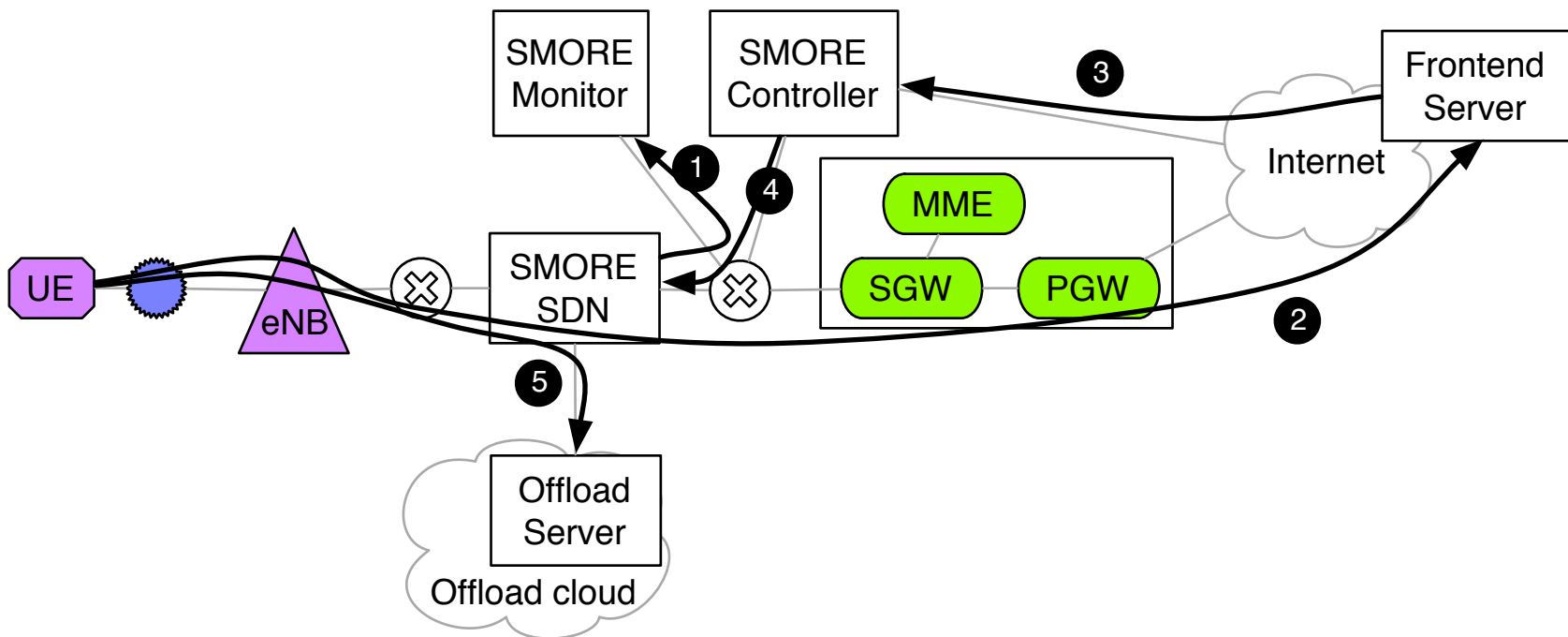# What can you do with PhantomNet?

- Role your own...

Documented examples

- Explore application and network interaction
  - ADB control of UE
  - FAPI monitoring RAN
  - Wireshark monitoring core

Documented examples

- Combine SDN with EPC
- Cloud offloading

Status

Open for business:

www.phantomnet.org

- Integrated OpenEPC with Emulab
  - Uses emulation for RAN (UE and eNodeB)
  - Specifies LTE/EPC topology using NS file with PhantomNet enhancements
  - Brings up experiment with correct e2e configurations

Status cont.

- Hardware RAN: current
  - Assortment Android devices
  - Off-the-shelf LTE eNodeBs
  - SDR rigs
  - 4 port RF attenuator matrix
  - Functioning with OpenEPC/OAI/OpenLTE in Emulab environment

Status cont.

- Hardware RAN: Soon
  - 32 X 16 RF attenuator matrix
  - Mix of:
    - managed Android devices
    - OTS LTE eNodeBs
    - SDR rigs

  - Full integration with Emulab control framework

Status cont.

- Using PhantomNet in my Advanced Networking course
- Lab Assignment
  - Combining SDN and cloud with mobile networking
  - Can make assignment available if folks would like to use in their courses
- Using for a number of class projects

Conclusion

- PhantomNet is open for business

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  We are looking for users...

- We will be doing a tutorial at IEEE CCNC in January