Advanced Networking: Introduction

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University of Twente | September 4, 2019

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Today's goal

- Provide an overview of Advanced Networking (ANET)
- Discuss past and future of the Internet (guest lecture by Mr. Kees Neggers)
- Answer questions you may have on assessment, deliverables, etc.
- Result: understanding of ANET and provide inspiration on the topic of internetworking

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Agenda

Time	What	Who
10:45-11:15	• High-level introduction to internetworking • Course overview • Introduction SIDN Labs	Cristian, all
11:15-11:30	Break	
11:30-12:30	Guest lecture: Reflections on the History and Future of the Internet (open)	Kees Neggers

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How the Internet works

(from a 50,000 foot perspective)

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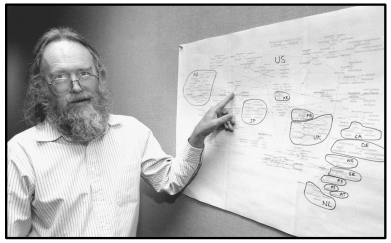
Wikipedia

- Internet: “the global system of interconnected computer networks that use the Internet protocol suite (TCP/IP) to link devices worldwide. It is a **network of networks** that consists of private, public, academic, business, and government networks of local to global scope, linked by a broad array of electronic, wireless, and optical networking technologies”

- Computer network: “a digital telecommunications network which allows nodes to share resources. In computer networks, computing **devices exchange data** with each other **using connections** between nodes (data links.) These data links are established over cable media such as wires or optic cables, or wireless media such as WiFi”



“The Internet works because a lot of people **cooperate** to do things together”
– Jon Postel (1943-1998)

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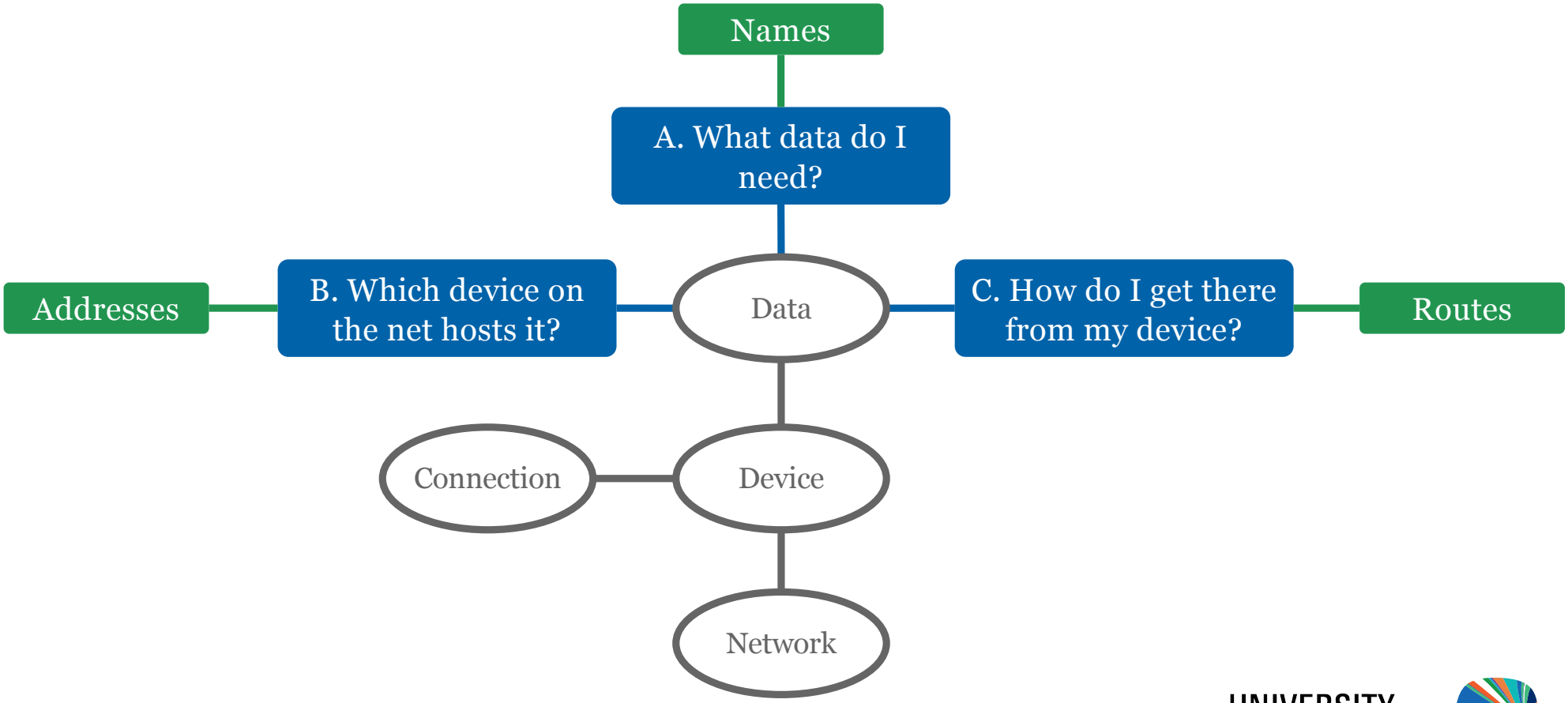
Key concepts of inter-networking (1978)

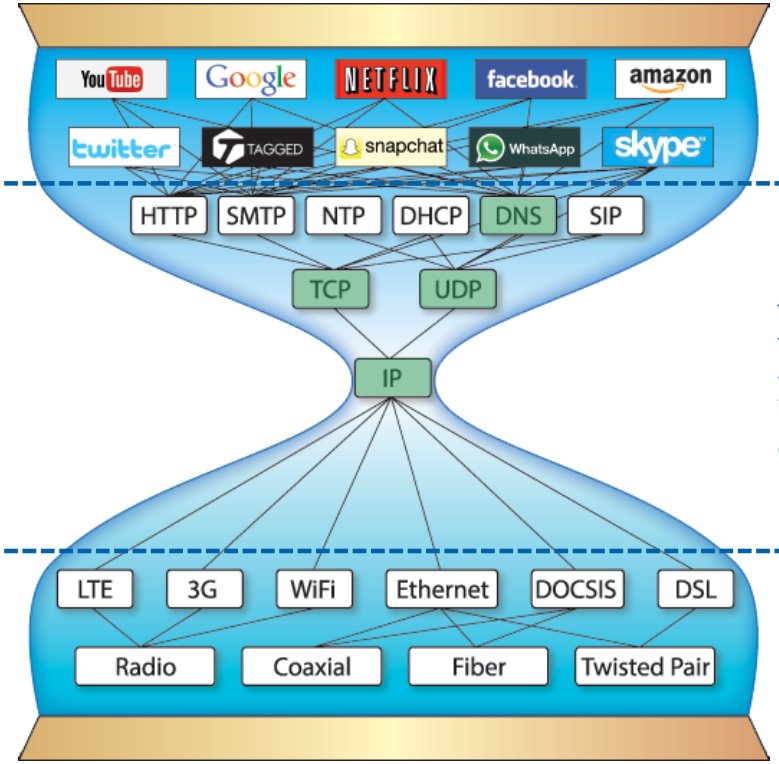


J. Shosh, "Inter-Network Naming, Addressing, and Routing", Internet Experiment Note #19, January 1978

Under the hood: protocols and services

Most people

You and us



Services

Names, addresses, routes ➔ Internet core protocols

Transmission

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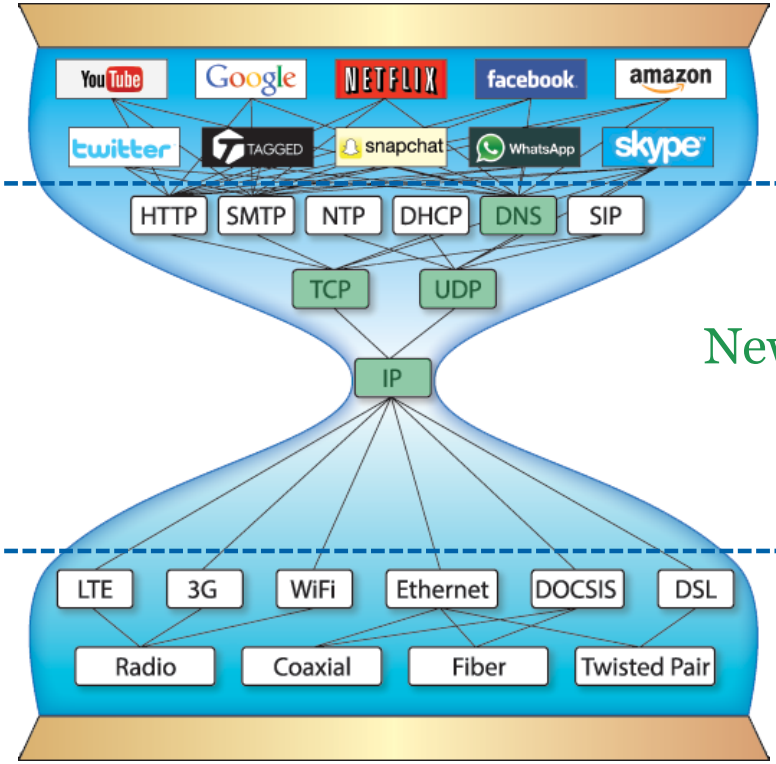
Rate of change

Fast

Slow!

Fast



New inter-network systems here

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First packet ever…

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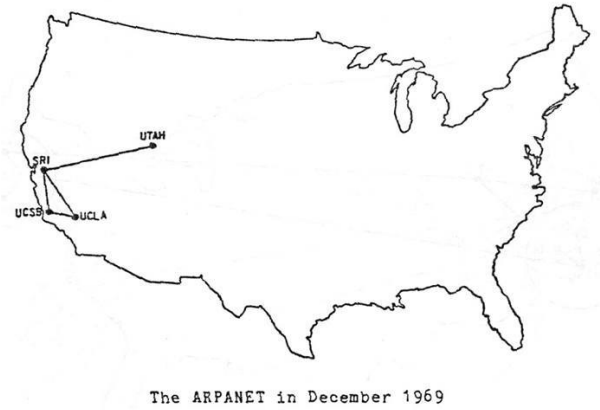
The origins of TCP/IP's design

Birthplace of the Internet
@UCLA, Sep 2017



The ARPANET in December 1969

Design decisions

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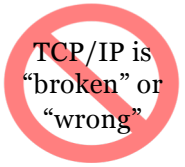
TCP/IP lessons learned

- Thin waist enabled worldwide deployment
  - Simple network layer (IP+BGP), weak demands on underlyi
  - Stateless, unreliable, unordered, best-effort delivery

- Issues investigated include:
  - Designed for point-to-point appli ersations"), not for multipoint (dissemination)
  - Security is an add-on, not a t of the core protocols
  - Does not support m ient between networks)
  - No support for q antees (e.g., latency guarantees for autonomous vehicles)
  - Local incidents ma have global effects (e.g., a CA compromise)
  - No path control and verification for applications that need it

MORE IN GUEST LECTURE



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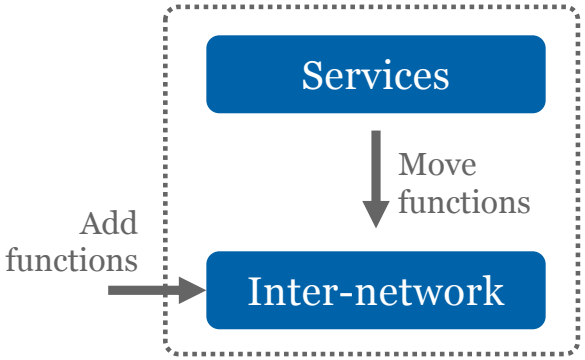
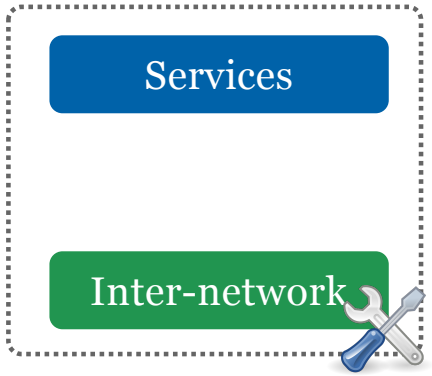
Proposed changes

Type 1: functional
Put functions not in TCP/IP in the (TCP/IP) network



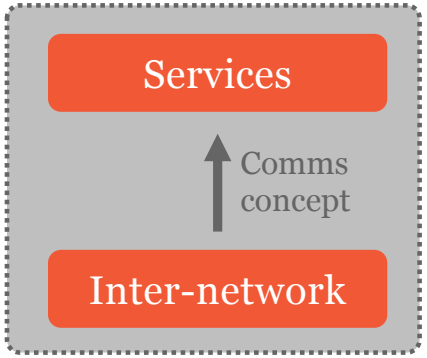
SCION
RINA
MobilityFirst
XIA
…

Type 2: design patterns
New generic structures for protocol stacks and/or (protocol) interfaces



RINA (layers)
XIA (addresses)
FII (interfaces)

Type 3: comms concepts
Network provides other comms abstraction than TCP/IP's host-based model



Data-centric
Service-centric
XIA, FII (future concepts)
ManyNets

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Course overview

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Objectives Advanced Networking

- Enable you to understand and evaluate advanced **internetworking concepts**, such as secure inter-domain routing, multi-path communication, and path control

- Further broaden your view by discussing both the **existing** Internet architecture as well as new experimental **non-IP-based** internets (e.g., NDN, RINA, and SCION)

- Help preparing the next generation of researchers and engineers to **stay in control** of future internet infrastructure in the Netherlands, EU, and worldwide

- **Prerequisites:** introductory course on computer networks, such as the bachelor module Network Systems at the University of Twente

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Learning outcomes Advanced Networking

- Analyze, compare, and discuss various advanced inter-networking concepts, such as secure inter-domain routing and multi-path data delivery
- Understand and discuss important challenges and proposed experimental solutions, including non-IP-based internetworking systems
- Apply a domain-specific language such as P4 to implement basic data plane functionality of an open programmable router
- (Enhance your research skills, because you will need to independently review, analyze, and present research papers)

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Assessment

- Goal: evaluate to what extend you attained ANET's learning goals

- Deliverables
  - **8 multiple choice tests** on papers/RFCs, one for each of the ANET lectures, to be completed both individually and in groups
  - A **presentation** of 30 minutes on one of the ANET papers, including 10 minutes of discussion
  - A **P4 program** that configures the packet handling functions of a P4-programmable network switch, to be carried out individually

- Pass if ((average score of 8 individual test)*40% + (average score of 8 group tests)*20% + (score of presentation)*40%) *(score of lab assignment) >= 5.5

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Deliverable #1: multiple choice tests

- Goal: assess your understanding of an introductory paper on the topic being discussed in a lecture

- Group-based learning
  - Together discuss the introductory paper of a lecture in teams of 3-5 + a group test
  - In addition to individual learning (and an individual test)

Time	What
10:45-10:55	Individual test (closed book) ➔ hand in test
10:55-11:10	Group discussion and test ➔ hand in test
11:10-11:20	Plenary discussion of paper/RFC
11:20-11:30	Break
11:30-12:00	Presentation #1
12:00-12:30	Presentation #2

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Deliverable #2: presentation

- At most 30 minutes: 20 minutes of speaking time and 10 minutes of questions and discussion
- Use slides to explain what the paper is about, particularly focusing on what you think are the paper's strong and weak points and how you would improve it
- Your lecturers will score your presentation, for instance based on clarity and mastery of the paper's technical content
- Your fellow students will use a feedback form to evaluate to what degree they understood the paper based on your presentation, teachers may use it to round off score
- If you want, you can send us an email indicating the 1st, 2nd, and 3rd choice of papers you'd like to present. Deadline **Wed Sep 4, 2019** (note: non-introductory papers only)

Deliverable #3: P4 lab assignment

- Goal: for you to program the packet handling functions of a (simulated) router using the domain-specific language P4

- You will need to carry out the P4 assignment individually during one or more lab sessions near the end of the quartile (dates to be announced)

- We'll announce the details through Canvas

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Important dates

- Individual and group tests: at each lecture
- Presentation: at the scheduled lecture
- Presentation review form: at the end of the lecture
- Lab assignment: to be announced
- Up to date schedule: see https://courses.sidnlabs.nl/anet-2019

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Staying up to date

- ANET homepage at https://courses.sidnlabs.nl/anet-2019
- Authoritative source for information about ANET
- Who will present which paper/RFC (first names only)
- Recommend visiting it every now and then

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ANET fact sheet

Advanced Networking (ANET)	
EC	5 (140 hours)
Prerequisites	Introductory course in computer networks, such as the bachelor module Network Systems at the UT
Coordinator	Cristian Hesselman (SIDN Labs, University of Twente)
E-mail	c.e.w.hesselman@utwente.nl
Lecturers	dr.ir. Pieter-Tjerk de Boer (University of Twente) prof.dr.ir. Geert Heijenk (University of Twente) dr. Roland van Rijsijk-Deij (NLnetLabs and University of Twente) dr. Cristian Hesselman (SIDN Labs and University of Twente)
Student assistant	Dennis Eijkel
Quartile	1 (Sep 4 – Nov 6, 2019)
Academic year	2019/2020

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SIDN = operator of the .nl TLD

- *Stichting Internet Domeinregistratie Nederland* (SIDN)
  - Manage fault-tolerant and distributed DNS and registration infrastructure for .nl
  - Increase value of the Internet in the Netherlands and elsewhere

- SIDN Labs = research team (~11 FTE)
  - Advance operational security and resilience of .nl, the DNS, and the Internet through measurements and technology development
  - Research challenges: core Internet systems (including IoT security) and Internet evolution
  - Daily work: help operational teams, write open source software, analyze vast amounts of data, run experiments, write academic papers, work with universities

.nl = the Netherlands
17M inhabitants
5.9M domain names
3.2M DNSSEC-signed
~1,5*10^9 DNS queries/day

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ANET is a collaborative course

- Motivation for SIDN Labs
  - Help educating the next generation of Internet (security) engineers and researchers
  - Aligns with our research area Internet Evolution and 2STIC research program (www.2stic.nl)
  - Perhaps interest some of you to check out our work for an M.Sc. project ☺

- Extends ongoing academic-industry research collaboration
  - SIDN Labs: improve security and resilience of SIDN's services and wider Internet using latest academic insights, methodologies, network, and creative thinking
  - University: further improved research and education using SIDN's operational experience, unique datasets, and industry network

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Coffee break

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Guest lecture: Reflections on the History and Future of the Internet

Kees Neggers

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Volg ons

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Q&A

Next lecture: **Wed Sep 11, 10:45-12:30**

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