



# Network Measurement and Software Defined WAN

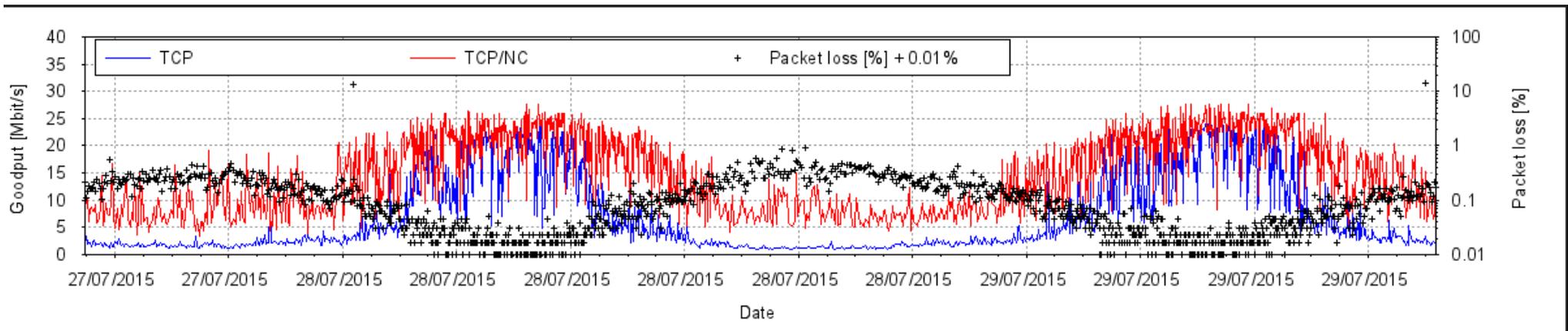
Dr. 'Etuete Cocker  
APNIC Community Trainer  
Head of Engineering - Exclusive Networks Pacific

# Beacon Network at the University of Auckland

- Co-developed the beacon software with Ex-PhD Supervisor Dr. Ulrich Speidel at the University of Auckland (UoA)
- Deployed the software in Tuvalu, Cook Islands, Niue, Tonga, Japan, Canada, South Africa, and Malaysia
- Each end node used TCP and UDP sockets to transmit and receive packets
- Type of experiments were uni and bi-directional file download, and a short 1-minute VoIP call
- After every experiment, the end node report to a server at UoA where we archive data and developed scripts to scan the data, and measure latency, jitter, packet loss, and hop count . We also use T-Entropy to measure how bad is the order of arrival of packets

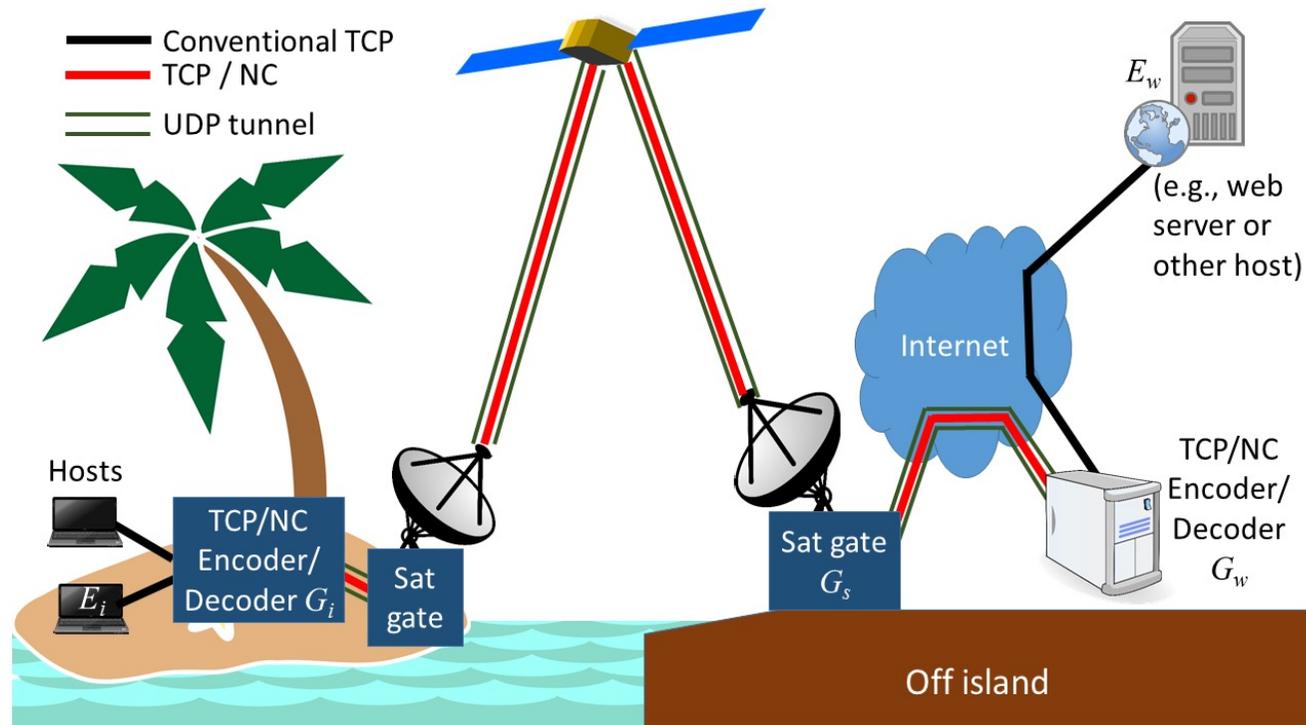


# Network Coded TCP at the University of Auckland



- Network coding converts IP packets into “combination packets” (“network encoding”)
- Instead of sending  $N$  data packets (IP packets) across the satellite link, we send  $M$  combination to make  $M > N$  packets. This is called overdetermined system of linear equations where we generate a system of linear equations whose solution is the set of original packets
- The decoder at the other end of the satellite link can recover the original  $N$  data packets from *any*  $N$  out of the  $M$  combination packets if they are linearly independent

# NCTCP at the University of Auckland



- Ongoing research by PhD student Wayne Reiher (Kiribati) and Ex-PhD Supervisor Dr Ulrich Speidel

# Definition of Software Defined WAN

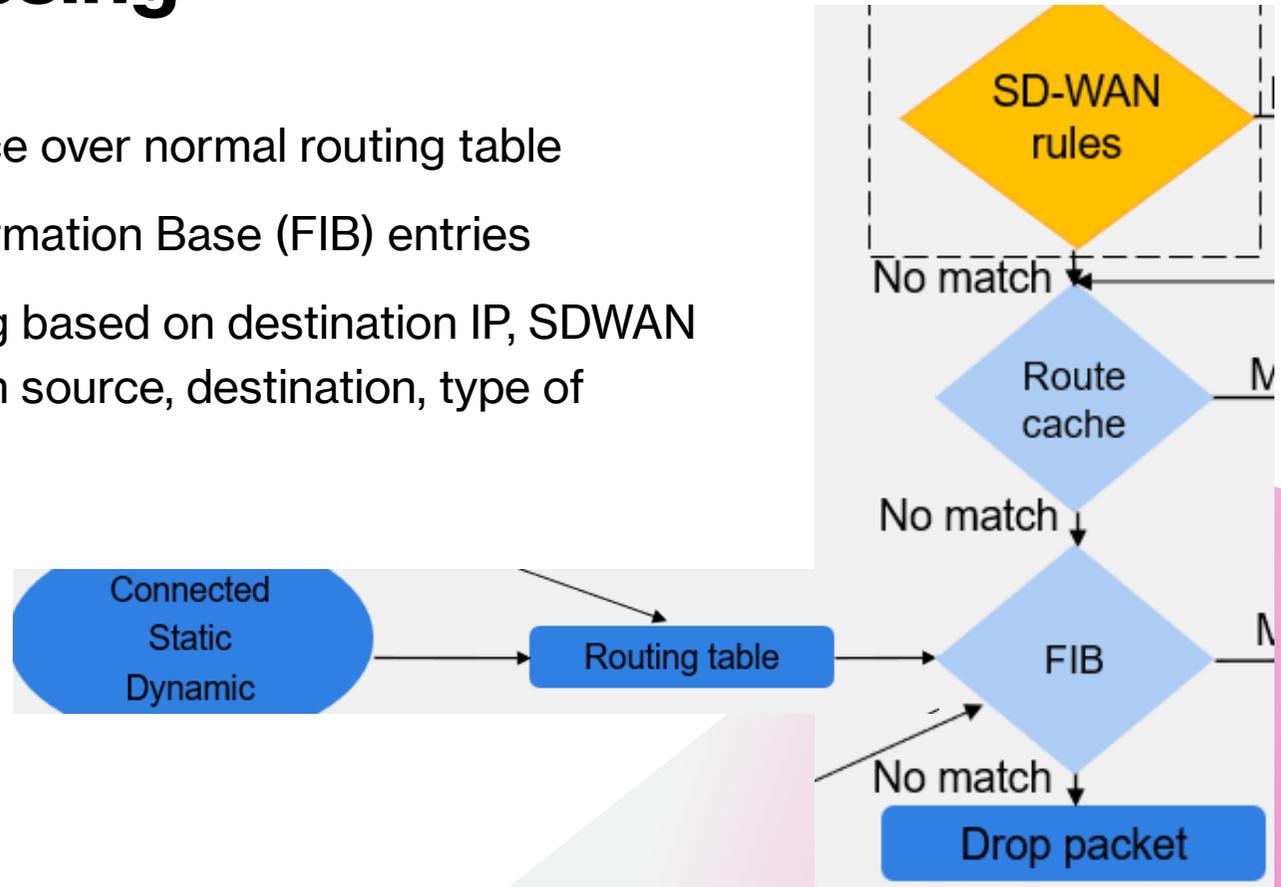
- Defined under RFC 7426 as the ability of software to program individual network devices dynamically
- 5 main planes and they are Forwarding, Operational, Control, Management and Application
- *Forward plain* is responsible for forwarding, dropping and changing packets
- *Operation plane* is responsible for managing the current state of member interfaces (dead or alive)
- *Control plane* is responsible for making decisions on the forwarding of packets
- *Management plane* manages dynamic configuration of traffic
- *Application plane* use operational, forwarding and control plane to steer application towards the best quality link

# Implementation of SDWAN

- Vendors interpret RFC 7426 differently
- Vendors such as Velo cloud and VMWare separate the Forwarding, Control and Management plane
- Fortinet and Palo Alto mix all 5 planes in a single box to achieve redundancy, load balancing, application steering and security

# Packets Processing

- SDWAN rules take precedence over normal routing table
- SDWAN require Forward Information Base (FIB) entries
- Differs from traditional routing based on destination IP, SDWAN rules match packets based on source, destination, type of service and application



Source - Fortinet SDWAN Implementation

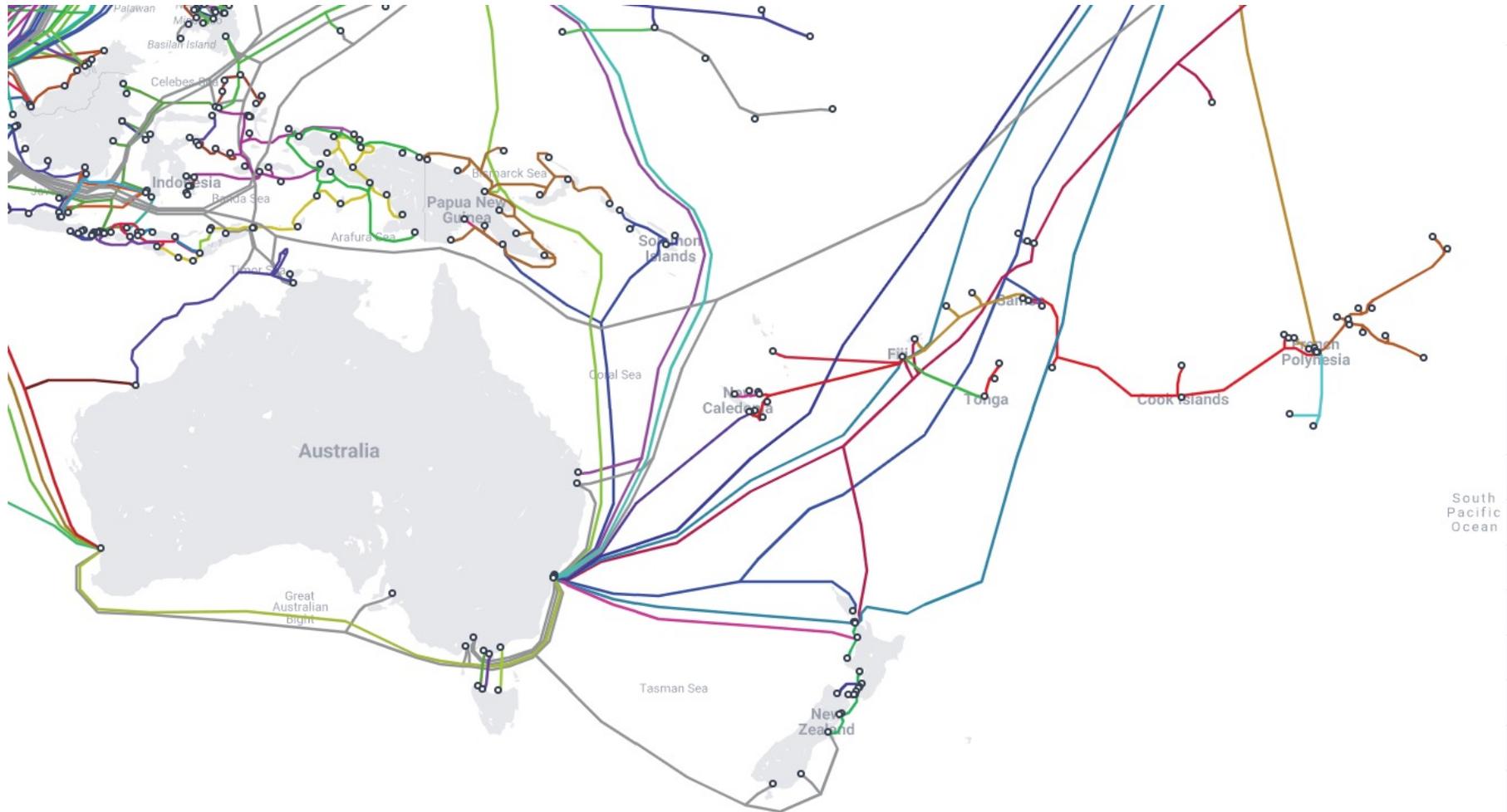
# Network Measurement

- Regardless of the implementation method, vendors perform active network measurement with protocols such as DNS, HTTP, ICMP, TCP echo, UDP echo, Two Way Active Measurement Protocol (TWAMP)
- Issues exist on the use of ICMP due to rate limiting at ISP
- DNS and HTTP are more reliable however this is not always available on all vendors
- Most reliable protocol is TWAMP and uses the same technique as the beacon network at UoA
- Passive measurement is an alternative measurement method where performance is based on TCP traffic passing through SDWAN members

# Why SDWAN in the Pacific?

- Most Pacific Island countries have transition plans or have adopted high-speed submarine cables
- As multiple links exist, SDWAN will be required for smoother transition of traffic between links. This is crucial for IXPs, and transit providers
- Advance SDWAN deployment method is a good alternative to BGP multi homing. The difference is dynamic reconfiguration of traffic flow and application steering
- Some vendors do not support security with SDWAN so be careful with your choice

# Submarine Cable Map (Pacific)



Source - <https://www.submarinecablemap.com/>

# Support for BGP

- BGP neighborhood and community are supported
- Internal and External BGP with multi path route advertisement is supported
- BGP route tag is supported for dynamic configuration of traffic flow
- BGP route reflection with SDWAN is supported on vendors that support multi hub dynamic VPNs

# Questions?