



Experiences with 64 bit PowerWorld Simulator

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PowerWorld User's Group Meeting

Portland, Oregon

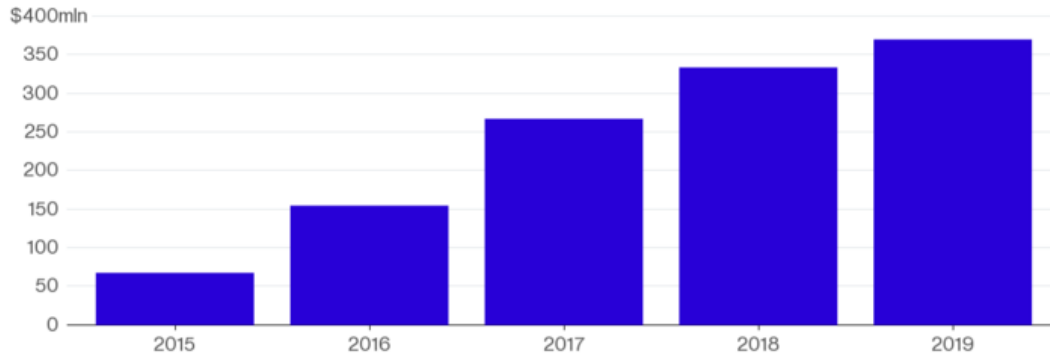
Avista (formerly WWP)

- Biggest of the small (~2200 MW)
 - Smallest of the big
 - 30,000 square miles (~size of SC)
- Serves Spokane (2nd largest city)
 - ZNation filmed here (SyFy, NetFlix)
 - New Load growth is “agricultural” (pays in cash)



Washington's Cash Crop: State Reaps Marijuana Tax Windfall

As pot sales climb, so does state's share of the revenue

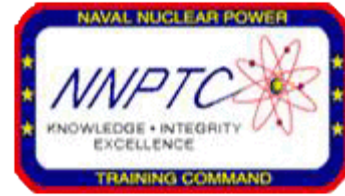


Source: Washington Economic & Revenue Forecast Council



The Avista logo, featuring a stylized 'A' icon followed by the word 'AVISTA' in a bold, sans-serif font. The logo is set against a blue background with a yellow horizontal bar above it.

Education



- Tracy Rolstad
 - Diploma, Naval War College, College of Naval Command and Staff
 - BSEE, University of Idaho
 - Nuclear Navy
 - Engineering Watch Supervisor (USS Hawkbill SSN 666)
 - Nuclear Operational Prototype (S1C)
 - Nuclear Power School (Reactor Operator)
 - Electronics Technician School
 - Radar, Communications, etc

Resume...



- Avista Corporation
 - Senior Pwr Sys Consultant, System Planning
 - WECC TSS Chair, Vice Chair, Secretary (former all)



- Utility System Efficiencies
 - Senior Power Systems Analyst



- The Bonneville Power Administration
 - Senior Engineer, System Operations



- The Joint Warfare Analysis Center
 - EP Senior Analyst, PACOM Chief of Targets
 - Special Technical Operations Action Officer



- Nuclear Navy (Attack Submarines)
 - Chief Petty Officer (ETC/SS)
 - Engineering Watch Supervisor

History of 64 bit Technology

- Processor, OS, and Applications

- Hardware, it has been a long time coming

- 1961: IBM 7030 uses 64 bit words
 - 1991: MIPS 64 bit processor available in SGI product line
 - 2001: Intel Itanium

- Operating Systems

- 1985: Cray flavor of UNIX
 - 1996: SGI IRIX
 - 2001: Windows XP 64-bit for Itanium
 - 2006: Windows Vista

- Applications

- 2017: PowerWorld Simulator

Advantages of 64 bit Environment

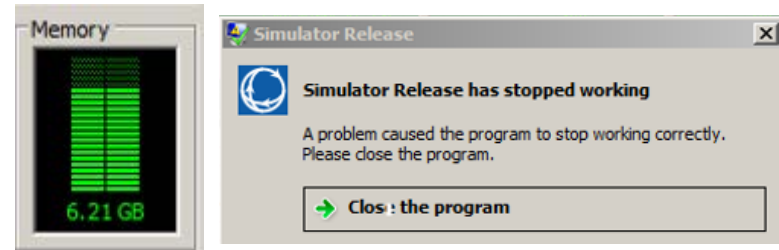
- One might (over)-simplify the advantages:
 - Registers: Speed of internal calculations.
 - Really probably already available (?)
 - Data-path: Speed of storage.
 - Address-path: Size of storage.
 - 4GB limit gone, goes to installed/addressable RAM as limit
 - Avista's server class machines sport 32 GB of RAM
 - Windows will page past RAM limit
 - » Might not be a good thing

Practical “Destructive” Testing Results

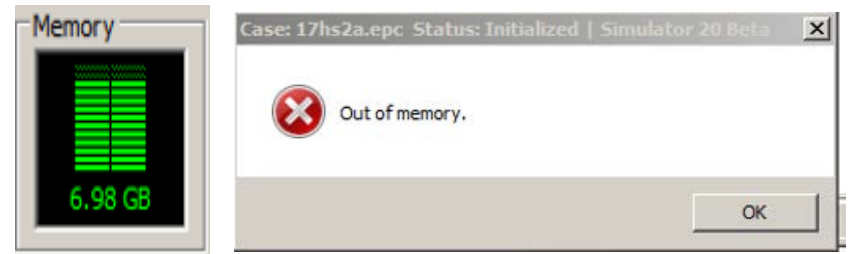
- ~63 million pwr flow ctgs
 - WECC N-2 >100 kV (i.e. BES doubles)

- Results

- 32 bit, laptop, 8 GB Ram



- 64 bit, laptop, 8 GB Ram



- 64 bit, server, 32 GB...paging to 1 TB Harddrive and it is still going...full 32 GB of RAM used.
 - Kind of thinking it broke...

Practical Limitations: Area 40 N-2 BES

	Skip	Category	Processed	Solved	Include Remedial Actions	Screen Allow	Post-CTG AUX	Islanded Load	Islanded Gen	Global Actions	Transient Actions	Rem Ac
5144012	NO		NO	NO	YES	NO	none					
5144013	NO		NO	NO	YES	NO	none					
5144014	NO		NO	NO	YES	NO	none					
5144015	NO		NO	NO	YES	NO	none					
5144016	NO		NO	NO	YES	NO	none					
5144017	NO		NO	NO	YES	NO	none					
5144018	NO		NO	NO	YES	NO	none					
5144019	NO		NO	NO	YES	NO	none					
5144020	NO		NO	NO	YES	NO	none					
5144021	NO		NO	NO	YES	NO	none					
5144022	NO		NO	NO	YES	NO	none					
5144023	NO		NO	NO	YES	NO	none					
5144024	NO		NO	NO	YES	NO	none					
5144025	NO		NO	NO	YES	NO	none					
5144026	NO		NO	NO	YES	NO	none					
5144027	Yes, this is > 5million			NO	YES	NO	none					
5144028				NO	YES	NO	none					

Violations

Category	Element	Value	Limit	Percent	Area Name Assoc.	Nom kV Assoc.
None	Defined					

Why 64 bit Matters?

- Creating/executing BIG tables of contingencies
 - Things in excess of 4 GB RAM limit
 - Like all BES N-2 in the NW (Area 40)
 - Can you REALLY say you have all N-2 covered?
- Doing this **REQUIRES** a server class machine
 - Our laptops simply died.
 - We think 19 hours to evaluate ~ 5 million power flow contingencies
 - Literally started it this afternoon...and it failed...again
 - The initial (after we built the ctgs) *.pwb size is 1.74 GB
 - Starting size was 18.3 MB (clean read from *.epc)
 - So 63 million ctgs might be a file size of 19.61 GB

64 bit Drives Need for Hardware

- You **NEED** to bring a **BIG** hammer!
- Server class machines are a must
 - CPU speed matters, RAM matters (32 GB at Avista)



Version	Limit on X86	Limit on X64
Windows 10 Enterprise	4 GB	2TB
Windows 10 Education	4 GB	2TB
Windows 10 Pro	4 GB	2TB
Windows 10 Home	4 GB	128GB

Version	Limit on X64
Windows Server 2016 Datacenter	24 TB
Windows Server 2016 Standard	24 TB

Big and Bad is Good

Titan X650 - Quad CPUs Intel Xeon E7-4800 / E7-8800
V4 Series HPC Super Workstation up to 96 cores


TITAN



UP TO 96 CORES

Our dream machine...

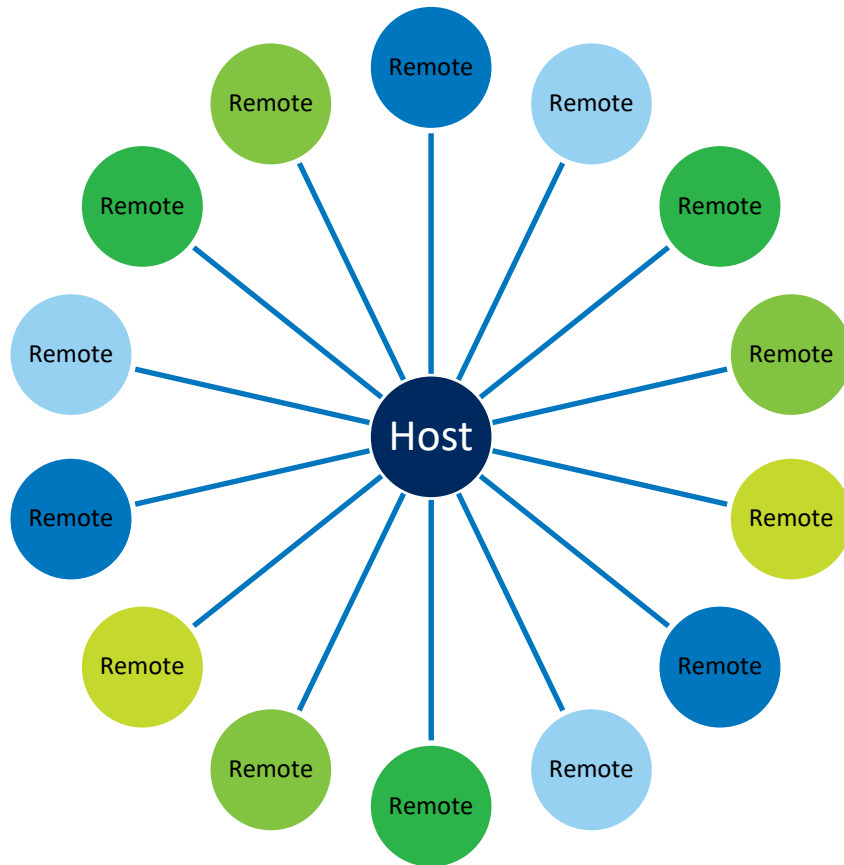
2 TB of RAM

X4 Xeon E7-8890 for 96 cores

~\$61K

Note that 2 machines=14, next slide

PowerWorld's *Distributed Computing*



- Uses all CPU cores on your PC for analysis
- We want to test N-2 with simulation
 - No “judgement”
- PWS is burdensome to use with > GB file sizes
 - Really a hardware issue?
 - Or can code be optimized?
- This IS the future



Thoughts

- Convergence of Software AND Hardware
 - 64 bit is nothing new (frankly neither is 128 bit)
 - 64 bit needs hardware, but that IS available
 - In GB range...not sure what 2TB RAM even looks like
 - They DO sell it! ~\$22K 🤪
 - Well, maybe like a SSD hard drive
 - 64 bit has arrived
 - CG issues solved?
- True RAM limit is?
 - 16 Exabytes
- No more judgement?
 - Simulate it



Conclusions

- 64 bit PowerWorld WILL be on your desktop
- Leverage the tool and think BIG
- PWC needs to look at optimization for BIG data
- Compliance is a driver:
 - Power swings, P6 Ctgs, many cases, short ckt
 - Need relay models
 - Big storage
 - More studies
 - More data for analytics
- Increased pressure on FTE
 - Maybe \$61K is a smoking good deal?