#### Taurus Seismograph Overview

Geological Survey of Canada April 29, 2007

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Based on:

Taurus FW 2.05.09 Taurus Manual R5





# Outline

- Introduction
- Features
- > Specifications
- ➢ Hardware
- > Software
- Using the Taurus
- Apollo Support Utilities



## Introduction



# What is a Taurus?

- All-in-one, portable seismograph
- 3 channel 24-bit digitizer
  - > > 141 dB dynamic range
- CF or ATA disk drive recording media
  - > over 2 years of continuous recording
- Low power, 750mW capable
- Embedded Linux OS
- Web browser user interface
- IP communications
- Real-time Data Streaming
- Three extracted data formats





# Taurus in System





# Modes of Operation

- Communications (real-time, configuration):
  - Continuous write to removable media
  - > Taurus configuration and data are accessible via ethernet or serial ports
  - Streaming to data acquisition server capable
- Buffered (low power, stand-alone):
  - Stand alone, unattended continuous data recording, no real-time comms.
  - Periodically writes data to removable media when buffer is near full capacity
  - Lowest power consumption
  - > Manual activation required for configuration and data extraction





- Sensor Input
  - Selectable number of Channels: 0, 1, 2 or 3
  - Selectable Hardware Gain: 0.4, 1, 2, 4 or 8
  - Maximum Input voltage range: 40 V peak-to-peak differential
    - at hardware gain = 0.4
  - > Nominal Sensitivity: 1 count /  $\mu V$ 
    - at hardware gain = 1
  - > Selectable Input Impedance:  $43.07k\Omega$  (low) or > 9M $\Omega$  (high)



- Digitizer Performance
  - Dynamic range: > 141 dB
  - Shorted input noise: <1 count RMS (of 24 bits) at 100 sps</p>
  - > Sampling rates: 10, 20, 40, 50, 80, 100, 120, 200, 250, 500 sps
  - Software Gain: 0.001 to 100 (user configurable)
  - ▶ High Pass Filter: user configurable 0.001 to 1.0 Hz



- Sensor Support
  - Sensor Types: Active or Passive
  - Sensor Power
    - Supply power passed through (9 36VDC)
    - Short circuit protection
    - Configurable: ON / OFF
  - Sensor Detection: configurable
  - Control lines: 6 user configurable
    - > Supporting Mass lock/unlock, mass center, cal enable, etc.
  - Mass position monitoring
    - ▹ ±10V range
    - > Automatic re-centering



- Sensor Calibration
  - Calibration Signal
    - ramped sine wave
    - pulse signal
    - pseudo-random binary
  - ≻ Mode
    - voltage or current
  - > Initialization: user interface



- Timing System
  - Internal VCXO clock disciplined to GPS
  - > Timing accuracy  $< 100 \ \mu s$
  - ➢ GPS Receiver: 12 channels
  - > GPS Antenna Options
    - ETEK MA-35 Patch antenna with integrated 5 m cable
    - Trimble Bullet III: 3.3VDC
      - Not compatible with Libra system (5VDC)
  - Duty Cycle: user configurable (automatic or always on)



- Data Storage
  - ▶ Removable media: Compact Flash or 1.8" IDE disk drive
  - Capacity support:
    - CompactFlash: tested up to 4 GB
    - 1.8" IDE hard drive: 20 GB to 60 GB
  - Duration: > 600 days of 3 channels @ 100 sps w/40 GB IDE drive
  - Recording mode: continuous ringbuffer
  - Storage Format
    - Nanometrics STORE (NP packets)
    - Steim (1) Compression
  - Data Extraction: MiniSEED, SEISAN, ASCII



- Communications
  - > Interfaces:
    - 10/100 Base-T Ethernet
      - DHCP / Static
      - Auto-MDIX
    - RS-232 serial
      - SLIP / PPP
  - > Protocols:
    - UDP/IP (unicast/multicast)
    - HTTP
    - RS-232 with IP drivers
  - > Streaming of multicast NP packets routed to selected default interface



- State-Of-Health
  - > Instrument SOH: voltage, current, mass position, GPS status, temperature
  - > User SOH: 4 external user accessible SOH channels (12 bit, digitized)
  - Logging: configuration changes, software messages



- Access Levels
  - User accounts have password protection
  - > Authorization model defines roles with various levels of access and associates each User account with a particular role
  - > Default accounts:
    - Highest Access Level: Username=central, Password=central
    - Medium Access Level: Username=tech, Password=tech
    - Default Access Level: Username=user, Password=user



#### • Power

- ▶ Input range: 9 to 36 V DC.
- Fuseless design with user configurable low and high voltage disconnect
- Reverse polarity and short circuit protection
- Power Consumption:
  - Ultra low: 0.750W @ 12V, buffered mode with CF
  - Low: 0.800W @ 12V, buffered mode with IDE hard drive
  - Mid: 2.3W @ 12V, communications mode with CF (ethernet or serial)
  - High: 3.3W @ 12V, communications mode with IDE hard drive, display active



## **Taurus Specifications**



# Mechanical Specifications

- Machined aluminum case construction
- Weight: 1.8 kg
- 3.5" Colour LCD (320 x 240)
- IP-67 Compliant (with connector caps on)
- Multi-colour status indicator LEDs
- Scratch and chip resistant finishing
- Keyed connectors to prevent incorrect cable plug-in



# **Environmental Specifications**

- Operating Temperatures (w/o insulation)
  - > With CompactFlash card:  $-20^{\circ}$  C to  $60^{\circ}$  C
  - > With IDE hard drive:  $5^{\circ}$  C to  $55^{\circ}$  C
- Storage Temperature:
  - > -40° C to 70° C
- Humidity:
  - ▶ With media door closed: 0-100% non-condensing
  - ▶ With media door open: under 90%
- Operating Altitude:
  - With CompactFlash card: No limit
  - > With IDE hard drive: -60m to 3000m



#### **Taurus Hardware**



# Taurus Components

- Analog Processor (TAP)
  - 3 channels 24-bit data channels
- Digital Processor (TDP)
  - > DSP, filtering, GPS engine, timing
- Control Processor (TCP)
  - > Linux OS, 128 MB RAM, 64 MB Flash, comms. interface, java based code
- User Interface (TUI)
  - Integrated colour display and keypad
- Backplane (TBC)
  - connectors, internally soldered



## Taurus Architecture

Taurus



### Taurus Components





### Taurus Components





#### Connectors

- 7 external MIL spec connectors.
- 1 internal, behind the media door.
- All connectors are keyed and are different in sizes.
- No duplicate connectors.



#### Connector Overview...





#### Status LEDs

- 4 status LEDs
  - > 2 for Unit Status
    - SuperLED
  - > 1 for Ethernet connection / activity
    - EtherLED
  - > 1 for Media Access status
    - MediaLED





## SuperLED

States:

- $\bigcirc$  <u>Off</u> Taurus is powered off.
  - <u>Solid Red</u> Taurus is booting up.

Normal conditions to capture data:

- **Fast Blinking Green** Comms. Mode
- Slow Blinking Green Buffered Mode.

Busy condition:

<u>Fast Blinking Yellow</u> - boot up, sub system init, etc.
 Warning / Fault conditions:

- Fast Blinking Red Comms Mode, door, batt, media, GPS
- Slow Blinking Red Buffered Mode, door, batt, media, GPS







### EtherLED

#### • States:

- $\bigcirc$  <u>Off</u> controller is powered down
- Solid Yellow controller is booting (~8 seconds)
- Fast Blinking Green networking enabled, link established
- Slow Blinking Green networking disabled
  - D <u>Blinking Yellow</u> Initial power up, diagnostics
  - Blinking Red networking is enabled, no link detected





## MediaLED

#### • States:

- <u>Green</u> removable media (CF/IDE)
  can safely be removed.
- <u>Red</u> removable media is mounted,
  in write mode, DO NOT remove.





## **Taurus Software**



## Software Overview

- 1. Software Introduction
- 2. Software Modules
- 3. Data Organization
- 4. Taurus Configuration
- 5. Real-time Data Access
- 6. Data Downloading



## Taurus Software Introduction

- First true internet device for the seismic market.
- Web server based data acquisition system, named *Apollo*
- "Thin client" approach, no special software required to interact with the Taurus.
- A networked Taurus can be accessed from anywhere in the world!
- Linux based operating system.
- User friendly upgrade mechanism





#### Software Modules





## Data Organization

- Data types: waveform (time series), SOH, configuration, etc.
- Format: STORE system.
- STORE object combines waveform, SOH and config data for a given time period all in a single file.
- Waveform data is stored in 1<sup>st</sup> difference Steim format.
- SOH & config data are stored in XML/RDF.
- Data is self describing (where, when, whom).



# **Taurus Configuration**

- All data types are recorded by default.
- Minimal configuration required to get data recording started.
- Units can be configured individually.
- Units can have its configuration uploaded as an XML file.
- All configuration changes are logged to the STORE for traceability.



## Accessing real-time data

- 2 protocols: UDP/IP or HTTP.
- UDP/IP:
  - > Broadcasts data packets to an unicast or multicast IP address.
- HTTP:
  - > Uses a TCP/IP socket and HTTP between Taurus and receiving software.
  - > HTTP allows POST and GET commands to/from Taurus.
  - > HTTP is implemented in all web servers/browsers.



# Data Downloading

- Request for specific data segments via web interface or HTTP commands
- Request for: time series data, SOH and config
- Option to directly extract data into MiniSEED, ASCII, SEISAN formats



## Using the Taurus



## User Interface

- On-board colour LCD.
- 5-button navigation.
- Access to acquisition system via web browser
- Functions
  - Real-time waveform data
  - > SOH data
  - Configuration information
  - Calibration commands





# Powering Up

- Basic Steps:
  - 1. Connect the GPS, sensor and ethernet cables (if applicable).
  - 2. Connect the power cable (9-36 V DC).
  - 3. The SuperLED will transition from solid red to blinking yellow to blinking red or green.
    - > The Digitizer, Controller and Timing subsystems are started when power is connected to the Taurus
    - > Typically about 3 minutes
  - 4. After 2 minutes, press and hold the center button for 1 second to activate the display (10 to 15 seconds)





- Channels
- Store
- IP
- Time
- Status
- Waveform

	🗿 Taurus Digital Seismograp	oh - Status - Micro	soft Internet Explore	er 💶 🗖 🔀
Status Pag	<u>E</u> ile <u>E</u> dit <u>V</u> iew F <u>a</u> vorites <u>T</u>	ools <u>H</u> elp		
	🌀 Back 👻 🕥 – 💌 😰	a 🏠 👌	Google -	<b>*</b>
	http://199.71.138.61/	pages/taurus/status.p	age	💙 🋃 Go
da	Status 💎			SN: 102 📥
de		Mode:	Communications	
1		Store(IDE):	27.3% of 400.00 MB	
annels	\ Menus	Store Time Left:	9.5 d	
	Home	IP:	199.71.138.61	
re	Button	Time:	2006-02-14 19:30:30	
		Temp: 22.8 °C	Power: 2.1 W Packets: 3243	
	Status Dara	GRS Failed Doo	r Closed Recording	
	Status Dars —	Sensor Power P	ovver Ethernet	
าค		and its	20 30	
		9.30 <u>0</u>		Near Real-time
tua	1	9:30	po po po po	Waveform
lus				
C	Ľ	9:301 1.4	F*	
veform				
				2
	🙆 Done			Second Intranet



## **5-Button Layout and Functions**





## Taurus Navigation: Menus



5-button pad





## Taurus Navigation: Fields/Links





#### Navigate Taurus Pages





## Accessing the Taurus

- From external web browser:
  - 1. Connect the Taurus using the ethernet cable (15228) to your LAN or computer directly.
  - 2. Open your browser and go to the Taurus URL: <u>http://Taurus.IP.Address</u>.
- The IP address of the Taurus is shown on the Current Status Page of the internal browser.



#### Ext. Browse

- IE/Netscape/Firefox
- Enter Taurus IP





# Login

- User:
  - ➤ central
- Password:
  - ➤ central

$\forall$	Status 🔀	SI	SN: 957	
Sto Sto	Status Waveform SOH Alerts Data Availability Data Retrieval Timing Sensor Store Tools System Info Log In Shutdown	nunications 100 sps % of 1.57 GB 0.1.15 -04-25 16:46:28 ower: 3.0 W :kets: 7311 Recording Ethernet	V Log In ▼ SN	: 957
163	<del>τ</del> 6 <sup>10</sup> , β0	40 ,	Userid: central	
163 E	46 <mark>20</mark> β0		Log In Reset	
162	46 <sup>20</sup> β0	<u>4</u> 0 ,		



## Menus

- Main menu pages:
  - > Status

٠

- > Waveform
- > SOH
- > Alerts
- Data Availability
- Data Retrieval
- > Timing
- > Sensor
- Store Tools
- Configuration
- System Info
- Advanced Configuration
- > Upgrade
- Log off
- > Shutdown





# **Configuration Page**



## **Advanced Configuration Pages**



# Advanced Configuration: Sensor Details

	Du	all	$\forall$	Advanced Confi	guration 💎	SN: 957			
			Sensor	r Details					
			Sensor	:	Trillium 40	✓ Add Del			
			Sensor	Name:	Trillium 40				
			SP/LP N	lode:	LP	~			
			XYZ/U	VW Mode:	XYZ	<b>~</b>			
			Calibrat	tion Mode:	VOLTAGE	<b>~</b>			
			Needs	Power:					
			Detect	Sensor Presence:					
			Sensitiv	vity Units:	V/(m/s)	~			
			Sensitiv	vity Value:	1500.000000				
Advanced Configu	ration 🔝		SI Sensor	Control Lines	Mass Auto-Centerin	q			
Sensor Control Lines			Previ	ous	Apply (	Commit Reset			
Sensor:	Trillium 40	✓ Add	Del			Y	Advanced Configurat	ion 🔝	SN: 957
Assert (On) Level:	ZERO	~					Sensor:	Trillium 40	Add Del
Deassert (Off) Level:	HIGH_Z	~					001001.		
Positive Voltage Level [V]:	PLUS_5	~					Red Threshold [V]:	2.0	
Pulse Duration [s]:	1	~					Auto-Center on Red:		
Ctrl Line 1 (pin H):	XYZ/UVW On=UV	~					Yellow Threshold [V]:	0.4	
Ctrl Line 2 (pin W):	SP/LP On=SP	~					Auto-Center on Yellow:		
Ctrl Line 3 (pin G):	Unused Deassert	~					Yellow Holdoff Time [h]:	1.000000	
Ctrl Line 4 (pin Z):	Ch 1 Cal Enable	~					Retries per Auto-Center	: 0	
Ctrl Line 5 (pin c):	Ch 2 Cal Enable	~					Retry Interval [min]:	1	
Ctrl Line 6 (pin Y):	Ch 3 Cal Enable	~					Previous	Apply Commit	Reset
Previous	Apply	Commit R	Reset				/ * * 2	Nanon	netrics

# Advanced Configuration: Communications

$\forall$	Advanced Configura	ation マ		S	N: 957	
	Communications					
	Default Interface:	Ethernet		~		
	Ethernet [	ata Strea	ming			
	Serial Port 1 5	Serial Port	2			
	Discovery					
	Previous App	ly Com	nmit R	eset		
	Advanced C	onfigura	ation マ		SN: 9	57
	Ethernet					
	Mode:		Static IP	)	~	
	Static IP Addres	SS:	10.10.1.	15		
	Static Subnet N	lask:	255.255	.0.0		
	Static Default G	ateway:	10.10.0.	1		
	Previous	Арр	ly Cor	mmit R	eset	
	Advar	nced Co	nfigurati	ion マ 🛛		SN: 9
	Data	Streamii	ng "			
	Strea	m NP Pac	kets:			
	IP Ad	dress:	2	224.5.9.35	;	
	Port #	ŧ	3	32004		
	Pre	vious	Apply	Commit	Rese	t





## Sensor Page

- Mass positions
- Sensor Consumption
- View waveform
- One touch functions:
  - Calibration
  - > Mass center
  - Mass lock / unlock
  - > Power on /off





## Data Availability

$\overline{\gamma}$	SN: 95								
Month Week Day Text									
🔇 Mar-Apr 2007 📎									
		s	м	т	w	т	F	s	
	>	18	19	<u>20</u>	<u>21</u>	22	23	24	
	$\gg$	25	<u>26</u>	27	28	29	30	31	
	8	1	2	3	4	5	6	7	
	$\gg$	8	9	10	11	12	13	14	
	>	15	16	<u>17</u>	18	<u>19</u>	<u>20</u>	21	
	>	22	23	24	<u>25</u>	26	27	28	
	_	Pe	rcer	nt Da	ita A	vail	able	9	_
		)	<50	<95	<99	<mark>9</mark> <1	00	100	
	Re	fres	<u>h</u>						







#### Time Series Data Retrieval

• Select data type Time Series



• Select channels

$\forall$	Data Retrieval 🔝		SN: 957
Channel	Selection		
Select	Channel	Overall 1	lime Range
	taurus_0957/band/timeSeries1/	2007-03-	20 21:49:44.480 - 2007-04-25 19:28:44.550
	taurus_0957/band/timeSeries2/	2007-03-	20 21:49:44.480 - 2007-04-25 19:28:44.550
	taurus_0957/band/timeSeries3/	2007-03-	20 21:49:40.360 - 2007-04-25 19:28:44.550
Next			
	Cu	rrent Cho	ices
	Data Type: Time	Series	Change Data Type
	Channels: none	e	Change Channel
	Start Time: none End Time: none	e e	Change Time
	Data Format: none	e	Change Format
	Station Info: Net	work: NE ion: STN01	Change Station Info
	Clear All Choices		



#### Time Series Data Retrieval

Select start time and duration • Select format  $\bullet$ 

$\forall$	Data Retrie	val マ			SN: 957					
Choose	the time to	downloa	d:							
Year	Month	Day		Time						
2007	April 💌	20 💌	0	:0	:0					
Duration Show Av	: 1 ailable Times	Hours	•	•						
Next	Next									
		Curre	ent Cho	ices						
Data T	<b>ype:</b> TimeSer	ries			Change Data Type					
Chanr	taurus_ taurus taurus	0957/ban 0957/ban 0957/ban	d/timeSei d/timeSei d/timeSei	ries1/ ries3/ ries2/	Change Channel					
Start T	ime: none				Change Time					
End T	ime: none				onunge nine					
Data For	mat: none				Change Format					
Station	Networi Station: Info:taurus_ taurus_ taurus_	k: NE STN01 0957/band 0957/band 0957/band	d/timeSer d/timeSer d/timeSer	ries1/: BH ries3/: BH ries2/: BH	Z <u>Change Station Info</u> E N					
Clear All	Choices									





### Time Series Data Retrieval

- Confirm choices and click download
- Confirm choices and click Indicate filename and destination

Data Retrieval 💎	SN: 957	Save As						? 🔀
Confirm your choices below are correct: The current version cannot download more than 488 Mi MiniSEED format.	Bofdata in	Save in:	🛅 testdownloa	ads	~	G 🔊 🛙	••	
This will use network.station.channel names and will loo NE.STN01.BHN	ok similar to:	My Recent Documents	STN01_tauru	ıs_0957_20070425_000000.sı	eed			
Current Choices		Desktop						
Data Type: TimeSeries CI taurus_0957/band/timeSeries1/	hange Data Type							
Channels: taurus_0957/band/timeSeries3/ taurus_0957/band/timeSeries2/	hange Channel	My Documents						
Start Time: 2007-04-20 00:00:00 End Time: 2007-04-20 01:00:00	hange Time	-						
Data Format: MiniSEED CI	hange Format							
Station: STN01		My Computer						
taurus_0957/band/timeSeries1/; BHZ CI taurus_0957/band/timeSeries3/; BHE	hange Station Info		File name:	STN01_taurus_0957_200	/0420_00	0000 seed	~	Save
taurus_0957/band/timeSeries2/: BHN Clear All Choices		My Network	Save as type:	.seed Document		1	~	Cancel



# Powering Down

• **<u>Do not</u>** just disconnect the power cable!



- Basic Steps:
  - 1. If in **Buffered mode** first wake up the Controller and display by pressing and holding center button for 1 second (takes ~1.5 minutes).
  - 2. Go to Shutdown page from the web browser's drop down menu.
  - 3. Select the Shutdown option.
  - 4. Wait for status LEDs to be blinking *slowly* to indicate the Controller has been shut down.
  - 5. Disconnect the Taurus power cable.



## Installing Removable Media

• Always properly power down the Taurus Controller before removing or inserting media (CF/IDE)

 $\wedge$ 

You may lose data if the media is removed while the Taurus Controller is running.

 $\wedge$ 

You may lose data if the media is not inserted before the buffer fills-up.





## Installing Removable Media...

- 1. Lift the plastic lever on the media door.
- 2. Twist the door knob counter clockwise to the unlocked position (lever is vertical).
- 3. Flip the lever flat against the door, allowing the handle to push against the chassis and causing the door to pop free/open.





## Installing Removable Media...

- Make sure Media Access LED is green OR the power is off.
- Gently pull on the end of the CF/IDE to remove it.
- Gently insert the replacement CF/IDE.





## Inserting Removable Media...

- Place and push the media door in place.
- Twist the knob clockwise to the locked position (horizontal).
- Flip the black plastic lever down as to lie flat against the door as shown.





## Formatting Removable Media

- 1. Login
- 2. Go to Store Tools Page
- 3. Select 'Format *media*'
- 4. Click Proceed to continue
- Format unformatted media
- Reformat inactive media
- Cannot reformat active media







### Removable Media Content

- Directory Structure
  - > /logs
    - ApolloError.log
    - Apollo\_2007xxyy.log
    - TaurusServer\_2007xxyy.log
    - System log, etc.
  - > /lost+found
  - > /store
    - Taurus\_SNxxyy\_00n.store
    - Taurus\_SNxxyy\_00n+1.store





# **Apollo Support Utilities**



# Apollo Light

- Used to extract data from Store files on a PC
- Same data availability / retrieval options as Taurus
- Running on local user computer or server
- Self contained Java web server
- Interactive web browser GUI, similar to Taurus
- Requires Java JRE 1.4.2
- Execute batch file: apollo *options*
- Options: port=8080, default 80
- Start web browser: http://localhost [:port]



# Apollo Toolkit

- Command-line utilities and scripts
- Download and manage waveform data recorded in a Store
- Store archive management (merge, copy, trim, reindex)
- Data conversion
  - > MiniSEED
  - > SEED
  - ≻ SEG-Y
  - ➤ Seisan

