Detecting Sports Concussions: Using Splunk as a Motion Analytics Platform

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During the course of this presentation, we may make forward-looking statements regarding future events or the expected performance of the company. We caution you that such statements reflect our current expectations and estimates based on factors currently known to us and that actual events or results could differ materially. For important factors that may cause actual results to differ from those contained in our forward-looking statements, please review our filings with the SEC.

The forward-looking statements made in this presentation are being made as of the time and date of its live presentation. If reviewed after its live presentation, this presentation may not contain current or accurate information. We do not assume any obligation to update any forward-looking statements we may make. In addition, any information about our roadmap outlines our general product direction and is subject to change at any time without notice. It is for informational purposes only and shall not be incorporated into any contract or other commitment. Splunk undertakes no obligation either to develop the features or functionality described or to include any such feature or functionality in a future release.

Your Speakers

JOHN HALEY

Splunk Enterprise Certified Architect

- ISC² CISSP
- GIAC GNFA
- GIAC GCIH
- EC-Council ECSA
- EC-Council CEH
- EC-Council CHFI
- CompTIA Security +

STEVE WEATHERLY

Splunk Enterprise Certified Power User

- Computer Engineer and Network Architect
- Specializing in Information Security
- Certified Information Systems Security Professional (CISSP)
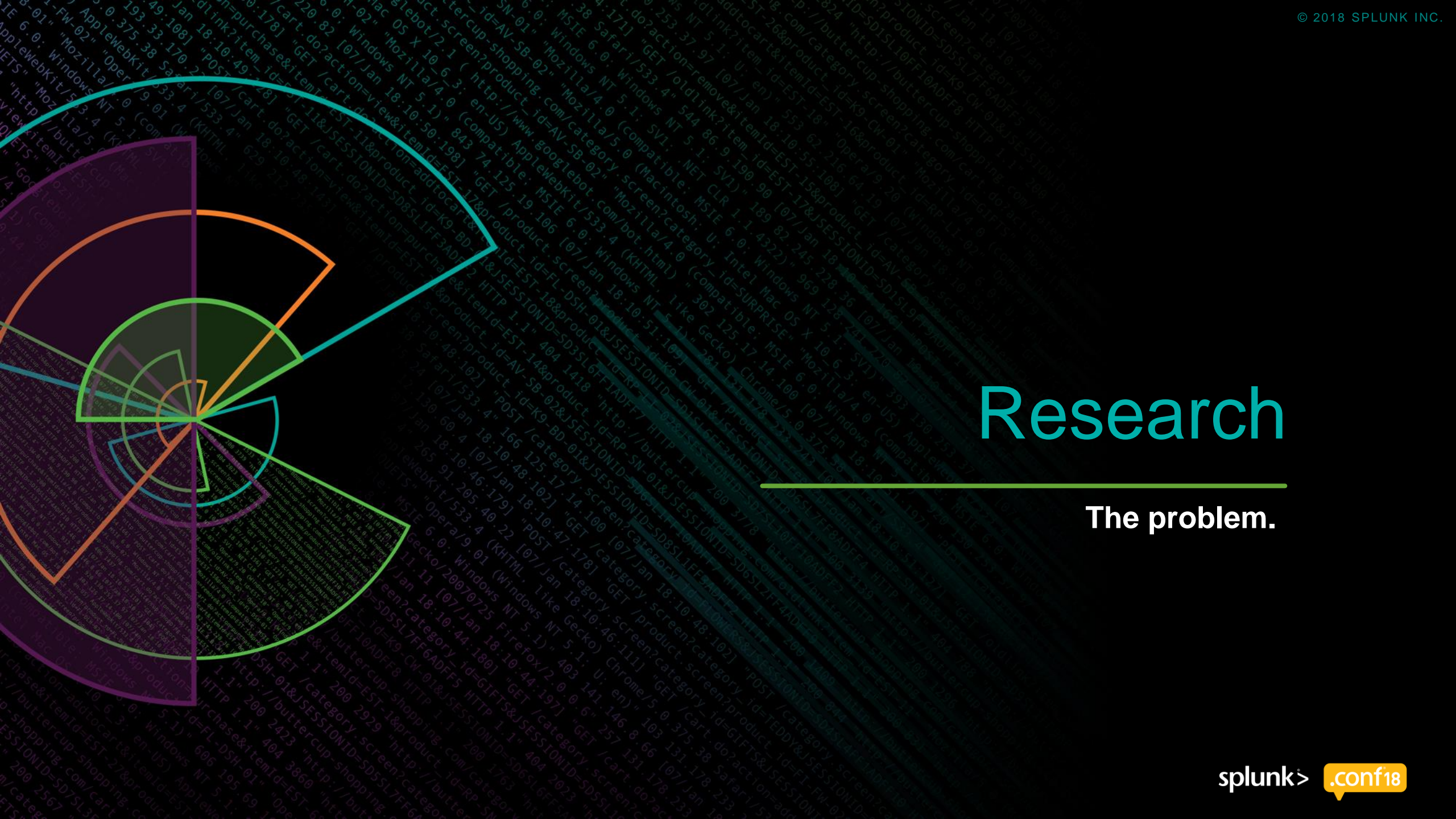- GIAC Certified Incident Handler (GCIH)

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Purpose

Our goal.

Purpose
Our Goal.

▶ We created ForceIntellisense to provide robust data analytics using a platform we all know and love!

▶ Goal was to simplify the to detection and analytic capabilities of the forces of movement.

▶ Our proprietary computational algorithms detect the specific pattern of concussive movements to determine the likelihood a concussion occurred.

▶ We aim to reduce the factor of diagnostic error in athletic injury analysis, particularly regarding forceful impact to the head and neck area.

Let's take a deeper dive…

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Research

The problem.

Research
The Problem.

▸ The area of research in relation to brain injury detection is still relatively new and untapped.

▸ Estimated that 5-10% of athletes will experience a concussion in any given sports season.

▸ **Football** is the most common sport with concussion risk for males at 75%.

▸ 78% of concussions occur during games as opposed to practices.

▸ Estimated 47% of athletes do not report feeling any symptoms after a concussive blow causing symptoms go untreated.

▸ CDC estimates that 1.6 million to 3.8 million concussions occur each year overall.

Current Event

- Just a few days ago, a high school football player in Georgia named Dylan Thomas passed away due to a head injury sustained during a game.
- No one knows exactly when during the game the head injury occurred.
- At first the injury was perceived to be a leg injury due to Dylan complaining of numbness in his legs, and later his entire body. Shortly after Dylan passed out and was rushed to the hospital where they discovered swelling of the brain.
- Unfortunately, brain injury related deaths happen much too frequently.

- Our goal is to prevent tragic accidents like this from happening.

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Why we use Splunk?

How we're different.

▸ Each of our sensors can natively run Splunk on-board!

▸ Allows us to visualize the real-time data using Splunk dashboards and reporting capabilities.

▸ Ability to run our time-based calculation algorithms on a cloud based architecture.

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Competitive Advantage

How we're different.

▸ ForceIntelliSense focuses on real-time, accurate analysis of impact on an athletes body. '

▸ Our biggest advantage is our advanced algorithm, speed of categorization, real-time visualizations of the data, and access to data from anywhere that has an internet connection over WiFi.

▸ Designed on a distributed architecture not based on a singular data collection device.

▸ Sensors capable of buffering time stamped data if/when network becomes unavailable.

▸ Data analysis available on Mobile devices via Splunk Cloud.

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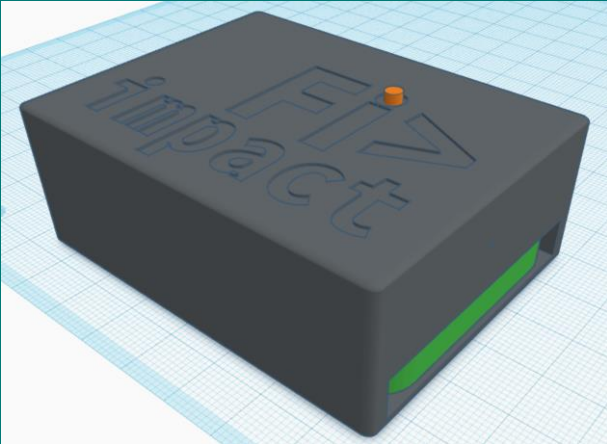
Intelligent Impact Monitoring

- Real-time collection of impact data

- Specific algorithms to detect concussive signatures.

- Ability to provide a centralized impact monitoring service.

- Accessibility of data from any network connected mobile computing device.

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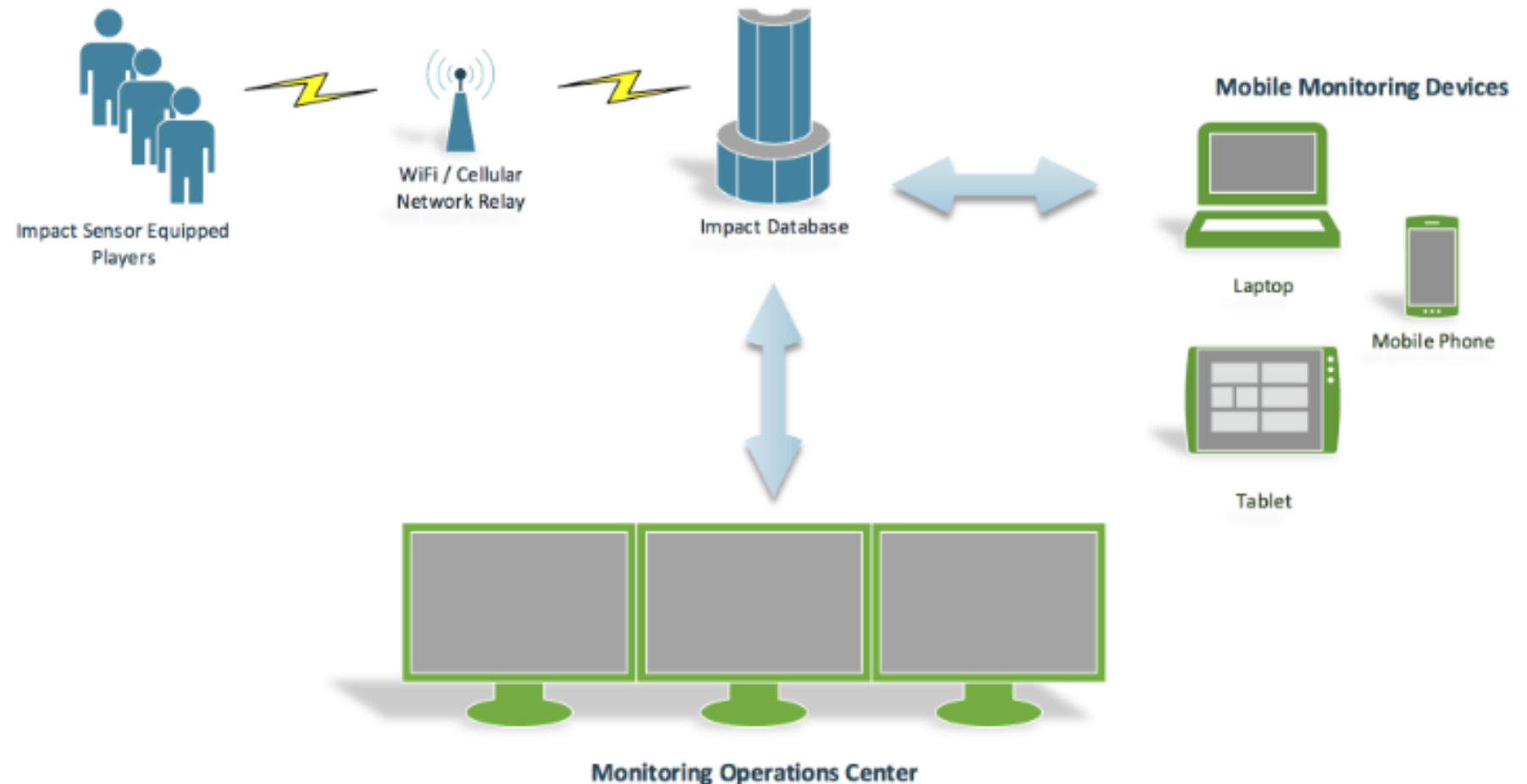
Design / Prototype Images

Version 1

Version 2

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Individual Player Analytics

Real-Time Impact visuals and statistics

Edit | Export ▾ | ...

1. Select a Player
2. Tap Jersey # to Confirm >
3. Select Time Period

S. Weatherly ▾ | ✕ | 32 | Last 4 hours ▾ | Hide Filters

Quick Access Menu

Player Visuals | Health Indicators - Offense | Health Indicators - Defense | Sensor Health and Alerts | Sensor Data Streams | Sensor Connectivity/Battery/Temp. Levels | Advanced Player Analytics

Player Information
Bio/Registered device Information

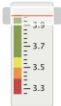|	Player Name ⇕	Player Position ⇕	Weight ⇕	Height ⇕	player_id ⇕	device_sn ⇕
1	S. Weatherly	WR	190	6'0	1000	0000-0000-0001

Sensor Connectivity
Connection state of sensor
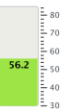
Entering Power Save [Disabling WiFi]
Connection Status

Sensor Battery Level (Voltage)
Last known device battery status

3.9
3.7
3.5
3.3

Internal Sensor Temperature (C)
Last temperature (C) within sensor enclosure

56.2

80 70 60 50 40 30

Highest Acceleration (G's)
Highest G reading within selected time period

25.0
Max Acceleration Experienced

Impact Alerts (CTE Signature)
Highest impact matching CTE movement algorithm

350
Max Impact Index

Acceleration Event Data
All acceleration events

	Time ⇕	device_sn ⇕	impact_id ⇕	resultant ⇕	prev_x_g ⇕	severity ⇕	x_g ⇕	prev_y_g ⇕	y_g ⇕	prev_z_g ⇕	z_g ⇕	batt_adc ⇕
1	23:30:58.465	0000-0000-0001	7	3.20	2.66	2	2.66	-0.25	-0.25	1.76	1.76	2007
2	23:16:24.143	0000-0000-0001	6	3.40	1.94	2	1.94	-2.43	-2.43	-1.40	-1.40	1978
3	23:16:24.124	0000-0000-0001	6	7.47	3.88	2	3.88	-6.31	-6.31	1.03	1.03	1980

« prev | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | next »

Impact Index Data
CTE Impact history

	Time ⇕	device_sn ⇕	impact_id ⇕	jerk ⇕	impact_initial ⇕	impact_final ⇕	time_initial ⇕	time_final ⇕	batt_adc ⇕	cpu_temp ⇕
1	23:16:24.164	0000-0000-0001	6	193.27	4.06	7.47	1535944584.10698	1535944584.12461	1981	49.2
2	23:16:24.042	0000-0000-0001	5	306.01	6.54	24.97	1535944583.94279	1535944584.00304	1979	49.2
3	23:16:16.629	0000-0000-0001	4	116.83	4.13	6.79	1535944576.57749	1535944576.60025	1976	48.7

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Acceleration Graph [Visual]
Acceleration event data

24.97

2.34

Resultant Acceleration
_time
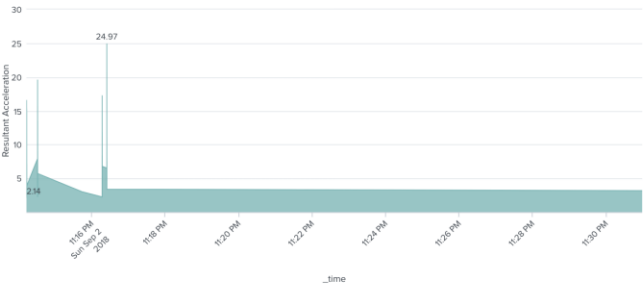
Impact Vector Graph [Visual]
Aceleration Components

14.78

-23.76

Aceleration Magnitudes
_time

— X Vector — Y Vector — Z Vector
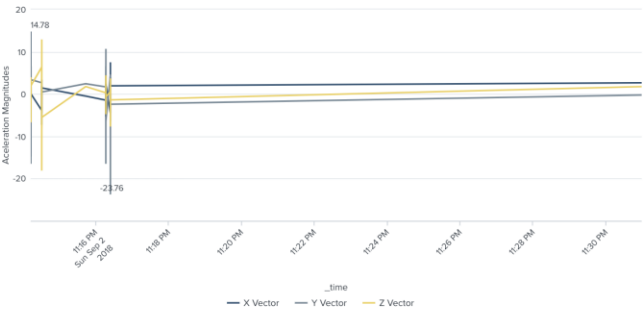
Impact Index [Visual]
Dynamic Impact
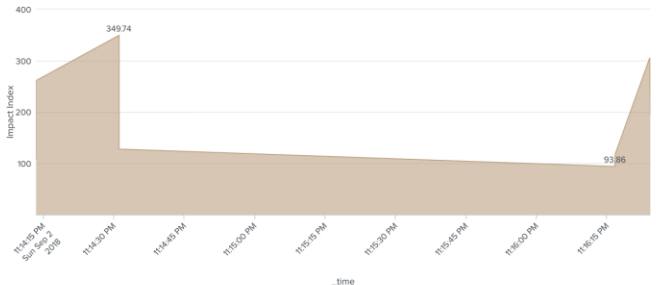
349.74

93.86

Impact Index
_time

Quick Access Menu

Player Visuals | Health Indicators - Offense | Health Indicators - Defense | Sensor Health and Alerts | Sensor Data Streams | Sensor Connectivity/Battery/Temp. Levels | Advanced Player Analytics

Health Indicators - Defense

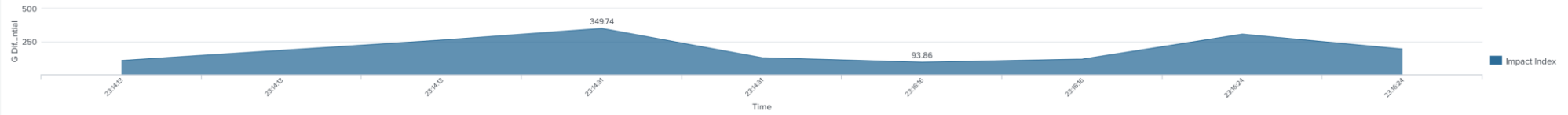Real-Time Impact visuals and statistics for multiple players

Select Time Period

| Last 8 hours ▾ | Hide Filters

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[University of Miami]

Displays the CTE impacts received by Team

S. Weatherly - # 32

349.7
Max Impact

S. Weatherly - # 32

349.7
Max Impact

S. Weatherly - # 32

349.7
Max Impact

S. Weatherly - # 32

349.7
Max Impact

S. Weatherly - # 32

349.7
Max Impact

Historical CTE impacts for player

Historical CTE impacts for player

Historical CTE impacts for player

Historical CTE impacts for player

Historical CTE impacts for player

S. Weatherly - # 32

349.7
Max Impact

S. Weatherly - # 32

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Max Impact

S. Weatherly - # 32

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S. Weatherly - # 32

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S. Weatherly - # 32

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Max Impact

S. Weatherly - # 32

349.7
Max Impact

Historical CTE impacts for player

Historical CTE impacts for player

Historical CTE impacts for player

Historical CTE impacts for player

Historical CTE impacts for player

Historical CTE impacts for player

Quick Access Menu

https://impact.forceintellisense.com:3201/en-US/app/ForceIntelliSense/health_indicators__defense?form.time_period.earliest=-8h&form.time_period.latest=now#

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Active & Shutdown Device Messages*

"Ready" and Powered down Devices

	Device Message ⇟	_time ⇟	Device ID ⇟	Player Name ⇟	Player Number ⇟
1	Sensor Device Active	2018-09-02 23:13:18.230	0000-0000-0001	S. Weatherly	32
2	Shutting down system, wait for delay (~10s), Goodbye.	2018-09-02 22:13:41.070	0000-0000-0001	S. Weatherly	32
3	Sensor Device Active	2018-09-02 11:12:52.920	0000-0000-0001	S. Weatherly	32
4	Shutting down system, wait for delay (~10s), Goodbye.	2018-08-31 05:52:25.170	0000-0000-0001	S. Weatherly	32
5	Sensor Device Active	2018-08-31 04:53:41.850	0000-0000-0001	S. Weatherly	32
6	Shutting down system, wait for delay (~10s), Goodbye.	2018-08-30 16:48:56.210	0000-0000-0001	S. Weatherly	32

« prev 1 2 3 4 5 6 7 8 9 10 next »

Time (NTP) Synchronizations*

Devices which have synchronized time

	Device Message ⇟	_time ⇟	Player Name ⇟	Player Number ⇟	Device ID ⇟
1	Time NTP synchronized.	2018-09-02 22:14:57.700	S. Weatherly	32	0000-0000-0001
2	Time NTP synchronized.	2018-09-02 22:13:41.070	S. Weatherly	32	0000-0000-0001
3	Time NTP synchronized.	2018-08-31 05:53:44.280	S. Weatherly	32	0000-0000-0001
4	Time NTP synchronized.	2018-08-31 05:52:25.170	S. Weatherly	32	0000-0000-0001
5	Time NTP synchronized.	2018-08-30 16:50:11.670	S. Weatherly	32	0000-0000-0001
6	Time NTP synchronized.	2018-08-30 16:48:56.210	S. Weatherly	32	0000-0000-0001

« prev 1 2 3 4 5 6 7 8 9 10 next »

Power Save/Idle Mode Messages

Devices which have produced Idle/Standby Mode message

	Device Message ⇟	_time ⇟	Player Name ⇟	Player Number ⇟	Device ID ⇟	IP ⇟
1	Entering Power Save [Disabling WiFi]	2018-09-02 23:33:58.880	S. Weatherly	32	0000-0000-0001	N/A
2	Exit Power Save [WiFi Enabled]	2018-09-02 23:33:18.330	S. Weatherly	32	0000-0000-0001	N/A
3	Entering Power Save [Disabling WiFi]	2018-09-02 23:31:39.050	S. Weatherly	32	0000-0000-0001	N/A
4	Entering Power Save [Disabling WiFi]	2018-09-02 23:31:39.050	S. Weatherly	32	0000-0000-0001	N/A
5	Exit Power Save [WiFi Enabled]	2018-09-02 23:30:58.490	S. Weatherly	32	0000-0000-0001	N/A
6	Entering Power Save [Disabling WiFi]	2018-09-02 23:17:05.030	S. Weatherly	32	0000-0000-0001	N/A

« prev 1 2 3 4 5 6 7 8 9 10 next »

Sensor Device Heartbeats

Periodical device check-in notifications

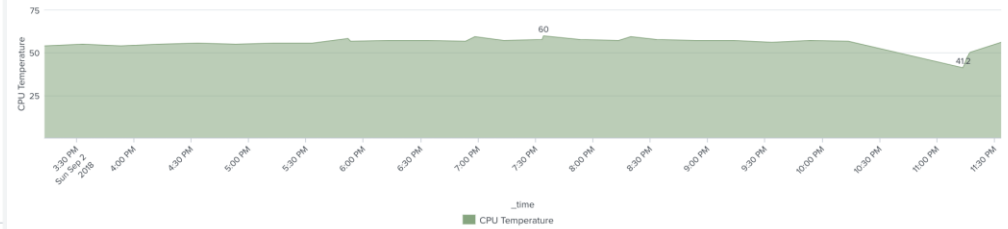|	Device Message ⇟	_time ⇟	Player Name ⇟	Player Number ⇟	Device ID ⇟	batt_adc ⇟	IP ⇟	cpu_temp ⇟
1	Heartbeat threshold (1200s), Checking In	2018-09-02 23:33:18.830	S. Weatherly	32	0000-0000-0001	1981	10.249.136.26	56.2
2	Heartbeat threshold (1200s), Checking In	2018-09-02 22:13:25.800	S. Weatherly	32	0000-0000-0001	1713	10.249.136.26	56.8
3	Heartbeat threshold (1200s), Checking In	2018-09-02 21:53:25.230	S. Weatherly	32	0000-0000-0001	1744	10.249.136.26	57.3
4	Heartbeat threshold (1200s), Checking In	2018-09-02 21:33:24.450	S. Weatherly	32	0000-0000-0001	1787	10.249.136.26	56.2
5	Heartbeat threshold (1200s), Checking In	2018-09-02 21:13:23.420	S. Weatherly	32	0000-0000-0001	1801	10.249.136.26	57.3
6	Heartbeat threshold (1200s), Checking In	2018-09-02 20:53:22.580	S. Weatherly	32	0000-0000-0001	1805	10.249.136.26	57.3

« prev 1 2 3 4 next »

Status Button Activations

Record of hardware button depressions

No results found.

Sensor Temperatures

Battery Usage

Battery Voltage information

Low Battery Device Warnings

Pre-warning of low battery devices

	Device Message ⇟	_time ⇟	Player Name ⇟	Player Number ⇟	Device ID ⇟	batt_adc ⇟
1	Low Battery Detected	2018-09-02 16:33:11.820	S. Weatherly	32	0000-0000-0001	1847

Critical/Low Battery Devices

Devices reporting very low battery status

	Device Message ⇟	_time ⇟	Player Name ⇟	Player Number ⇟	Device ID ⇟	batt_adc ⇟
1	Critical Low Battery Detected, begin shutdown.	2018-09-02 22:13:27.480	S. Weatherly	32	0000-0000-0001	1645
2	Low Battery Detected	2018-09-02 16:33:11.820	S. Weatherly	32	0000-0000-0001	1847

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Demo / Q&A

Steve Weatherly | Co-Founder

John Haley | Co-Founder

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Thank You!
Contact Us:

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- john@forceintellisense.com

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