

SEN)RATO

*Innovative Wearable Technology and Wireless Solutions*

## **Sendrato Wearables for Smart Events**

White Paper

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## *Introduction*

Compared to nowadays common RFID based wristbands, a Sendrato wristband takes a giant leap forward. Sendrato wristbands can do anything that ordinary RFID wristbands can do. It can be used for access control, cashless payments, social media interaction, crowd control and brand activations. Hence, anything that RFID-based companies advertise with on their websites, the Sendrato wristband can provide. However, zooming in to some of these allegedly claimed functionality is actually quite cumbersome when used in practice. Any festival goer will agree that social media interaction is not quite what you would expect of it in this modern online world. It is not the same experience as flipping your smartphone from your pocket and sharing a special moment with those who could not make it do this great event your attending. When you are listening to this great performance, after finally finding this perfect spot in front of the stage, you do not want to leave your hard fought position for doing a social media checkin to share this with your friends. At the same time, when you lost your friends in the crowd, desperately seeking them, while your cell phone is refusing to operate, you want to be able to locate them fast and easy.

Festival organizers will definitely admit that crowd control is not exactly what they expected in the first place. In the mind of the Security Manager he expects real-time instantaneous insight in the complete crowd all over the festival. How many visitors are currently standing in front of the main stage? How busy is this particular part of the food court? When looking for a certain individual, who could be a security threat, you want to locate this person as soon as possible, in order to send you security staff in the right direction.

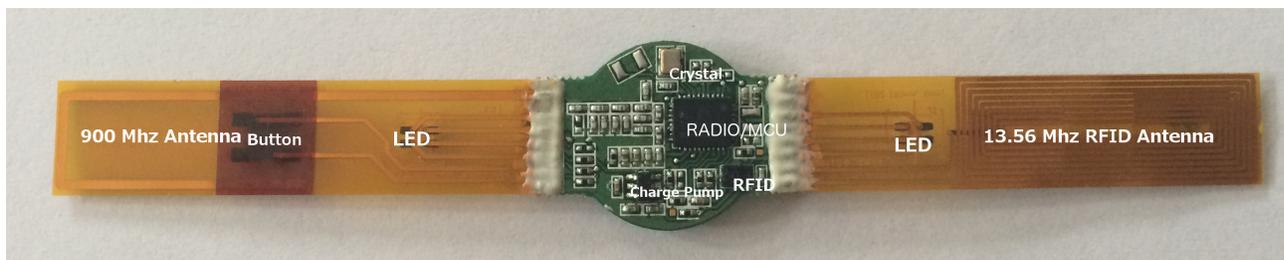
All this wonderful functionality is in fact not possible with those state-of-the-art acclaimed RFID wristbands. This is where our smart wristband solution enters the field. In this respect Sendrato wristbands are truly state-of-the-art. They do offer ubiquitous crowd control features and non intrusive social media interaction and much more. The main enabler for all of this being: bi-directional long range radio communication. This is a fancy phrase for a technology that all of us are using every day at home and in our jobs. This is exactly what WiFi or Bluetooth (BLE) does. However, we did not implement WiFi/BLE in our Sendrato in our smart wristbands. If the solution was that easy any RFID-based wristband company would have already implemented this. The reason why it is not so easy can be found in the following: cost, energy consumption and large masses. WiFi is not very good in all of these areas. It is costly, consumes a lot of energy and completely fails when thousands of people are trying to use it. Of course, our solution is not made for streaming YouTube videos and syncing your Dropbox with your phone. BLE is not so very good for use in large masses, it also fails when thousands of BLE transmitters are packed together in a small area. But, we can realise all of the aforementioned functionality for low costs, low power consumption and for very large crowds. Sendrato smart wristbands enable a level of interaction that enables the crowd to be part of the show. Our wristbands do not have a full fledged LED screen, that would compromise the cost factor, but they do feature two RGB LEDs that makes them part of a light show. It can be used to alert certain staff about an incident that took place. At the same time, the wristbands communicate with a special radio-network infrastructure to report their position or information from integrated sensors like temperature, battery level and a push button. Especially the push button can be used to facilitate hassle-free social media interaction. Instead of walking to a check-in station, a visitor can interact directly and instantaneously with a simple button right at their wrist. Also it can be used to “connect” two wristbands together in order to facilitate exchange of business cards or implement a friend connect.



### *Inside the Sendrato Wristband*

A Sendrato wristband can appear in multiple bracelet incarnations. It could be a leather bracelet, a textile wristband or a silicon wearable. What really matters is in the inside. The current version of our wristband contains the following components:

- Radio/microcontroller (MCU)
- CR2032 battery
- Two bright RGB LEDs
- RFID/NFC chip
- Button
- Clock
- Antennas



*Fig. 1: A Sendrato Smart Wristband Module. Note that the battery, LEDs and button are positioned on the flip side.*

Together these parts cooperate to form our unique smart wristband solution. The software running on the MCU controls the operation of the wristband. It controls the radio communication, the LEDs and the behaviour of the button press.

The MCU can wake up from its deep sleep mode in several ways. On wakeup the MCU starts its normal operation by listening to radio messages transmitted from a base station. The base station messages synchronises the wristband clocks and send commands either to particular wristband or to all wristbands. The commands instruct the MCU to light up the LEDs. Each wristband can be addressed separately by means of a unique ID. This unique ID is associated with personal details of the visitor wearing the wristband.

The button can be used for several user inputs. Two examples are “Music Like” and “Friend-Connect”. The Music like works as follows: When the button of the wristband is pressed for a moment, the location and time will be registered in that users data file. This is then correlated with the music played. We detect this music with a real time music discovery method (continuous and automated). This information together can be used to send a “Playlist” to the used in an App, web site or email. The music tags can also be used in more advanced communication to the visitor.



A Friend is Connected by its information (which is enabled during registration) by holding the button for 2s until the LEDs light up blue. By holding the wristbands in close proximity of each other, the LEDs flash green and a connection is made (in our cloud data base).

### The Sendrato System

The full system consists of

- A large number of wristbands (~100k)
- A base station infrastructure (~100)
- A server infrastructure (~10)
- A scalable (hybrid) cloud based database

The wristbands communicate using a unique protocol that directs all the traffic in such a way that thousands of wristbands can communicate their messages to the same system in a very short time (e.g. 30s). In addition,

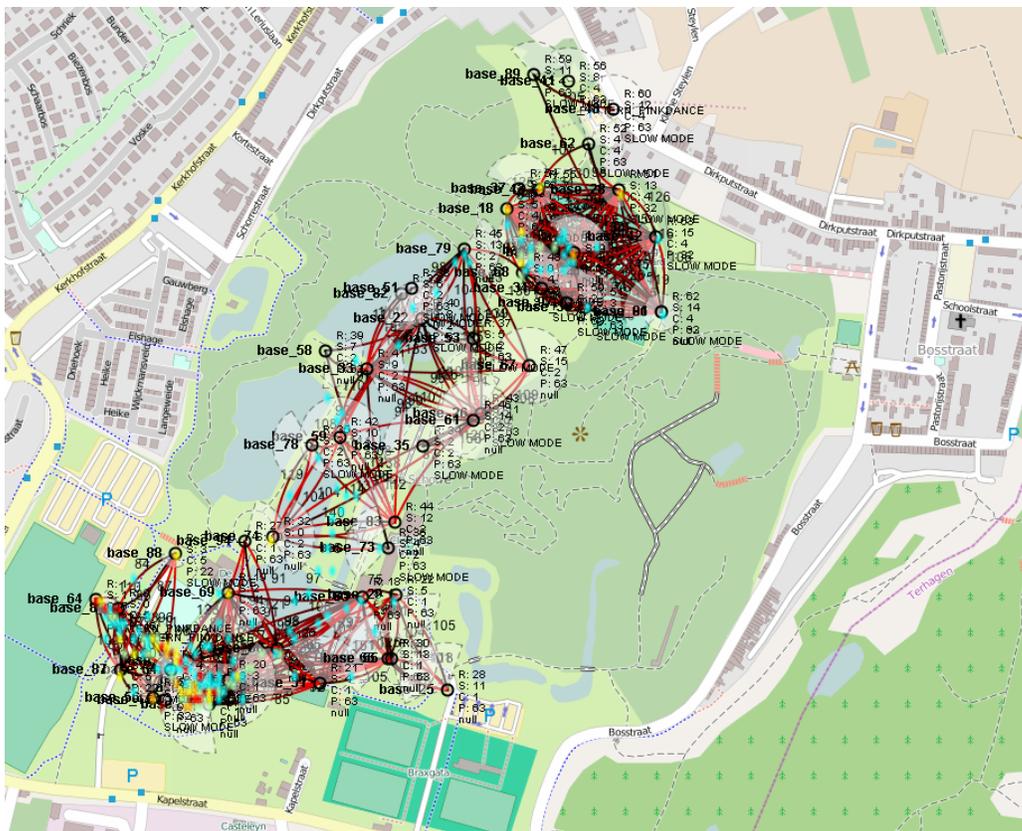


Fig. 2: Live snapshot of a base station connectivity-map at Tomorrowland 2014. 60 base stations are deployed here.

the wristbands are continuously synchronised resulting in [an impressive symphony](#) where each and every wristband lights up simultaneously during the light show. By exploiting the notion of



“near basestation” we can estimate the position of each wristband in near real-time (every 2-6 minutes depending on the total number of wristbands).

The base stations contain a matching, but more advanced 4-way radio. The base station radio is controlled by an ARM based PC board running Linux and our base station software. The base stations themselves are joint together in a software cluster. We have developed a unique redundant-communication protocol that enables the use of multiple physical communication layers between the base stations. We support TCP/IP based communication, both Ethernet and WiFi, as well as several low-bandwidth wireless communication technologies. Altogether this creates a fault-tolerant communication channel between the base stations. If for example the Ethernet or WiFi infrastructure fails the messages are still send using the alternative available wireless infrastructure, making the system independent of the festival infrastructure. A typical communication use-case is a message that originates from a wristband, being received by 1 or more base stations and further transported to our server node(s).

The server infrastructure is partly deployed locally on the festival premises and partly in the Sendrato Cloud. This setup enables Mobile Apps that are running on the visitor’s smartphones to interact with the system. Again, for fault-tolerance reasons, the server infrastructure can be setup redundantly. Failure of a server node does not result in failure of the entire system. A management console is available for operators to control the entire system. Furthermore, we are able to update the software on each base station simultaneously with a single mouse click in a matter of seconds. The messages that are received from the wristband are used to perform real-time triangulation to drive our crowd management system, heat map visualisation and individual wristband tracking.

Over the course of a festival millions of messages are being collected. Those message are stored in a highly scalable distributed database. The database contains information of all the visitors. It is completely up to the festival organiser to determine which kind of registration information is mandatory or optional. This data can be imported from the ticketing database or, depending on the capabilities of the ticketing database, automatically synchronised. The visitor database is replicated in real-time to cloud instances.

### *Continuous Data Collection in the Festival Hub*

In the introduction of this white paper we have briefly touched upon all the possibilities that the Sendrato wristband may offer. Just like ordinary RFID-based wristbands, the Sendrato wristband supports both RFID based access and NFC controlled Cashless Payments. Together with our partners this functionality can be delivered seamlessly. From the perspective of a Access/Cashless provider the Sendrato solution may just look like any other wristband provider that carries an RFID tag that supports their functionality. However, if a festival organiser wants to optimally exploit our solution, this is not completely the case. In today’s ventures, possessing data about your customers can make a huge difference in the global marketplace. The same holds true for festivals. Festival organisers can exploit behavioural data of the visitors in many ways. Many Access/Cashless providers have recognised this as well, that is why they are eager to claim that they can collect all the possible information about the payment and festival roaming behaviour of the visitors. Most certainly, using information collected by cashless payments results in interesting customer insights, that can definitely be delivered by the cashless provider. However, many important questions about a visitor with respect to festivals, like “what music



does she/he like?” cannot be answered by the solutions offered by RFID-based Access Control providers. By trying to persuade visitors to use check-in points some information that leads to the answer of this questions can be collected. But only partially and by far not a complete overview for all of the visitors. On the contrary, our solution is able to answer this question fully and completely. Leveraged by long-range radio communication all the information is collected non-intrusively without the need to come up with artificial incentives, i.e. check-in portals, to indirectly gather this data. In this respect, our solution is truly revolutionary in the current constellation of access/cashless providers on the one hand and wristband providers on the other where the data is completely controlled by the former. In fact we complement this picture by offering a true space and time dimension to the collected data. This means that providers of access and cashless must open up their data to be integrated in what we call the *Festival Hub*. Since we offer completely trajectory information of every visitor and crew in the festival it makes sense to put our Festival Hub in a central position, the main data collection hub. As a side effect this should also open the way to standardisation within the festival world. Standardisation of access control and standardisation of cashless payments. This is a very good thing for festival organisers, it prevents vendor lock-in on these commodity services. It will be easier for festival organisers to switch suppliers. We are distorting the current playing field with our smart wristband solution for the benefit of our customers.

### *Crowd Control and crew tracking*



Fig. 3: A live heatmap snapshot showing crowd densities in the entire Tomorrowland 2015 area

The localisation feature of the wristbands can be leveraged to support various functionality that can be beneficial for improving visitor experience as well as for providing important real-time crowd dynamics data to the security staff. Location information can give guidance to visitors based on real time location data. Both about crowded stages, that can be better be avoided,



and about showing the whereabouts of your friends. Lost friends is a scenario known to all festival goers.

Having knowledge about the density of people at any moment in time all over the festival premises can definitely improve the safety on a festival. Being able to spot locations that are becoming too crowded can trigger appropriate actions that needs to be taken in order to resolve such an unwanted situation. By setting appropriate alert levels on critical crowd density levels the security manager of a festival can perfectly monitor this behaviour by means of heat-map visualisations of the crowd density.

In addition, being able to track your security staff gives yet another dimension in helping you to find solutions to your security problems.

### *Social interaction and entertainment*



*Fig. 4: Wristbands light up in front of the Tomorrowland 2014 main stage*

A festival is all about fun and entertainment and enjoying your favourite music with people with similar minds. Of course security, access control, cashless payments, business intelligence and all that are very important aspects when organising a festival, but the true spirit comes from something else. The reason of being, the true motivator for every festival organiser, is this amazing feeling when you witness you crowd being overwhelmed by the story and setting that you have created for them. Enhancing exactly this experience, exploring the frontiers of excitement, is what festival organisers are constantly doing. Joining the boring/material aspects of the festival with spirit is what Sendrato wristband are in fact offering.

Besides presenting a jewel to the visitor, it enables the visitor to become part of the show and a true ambassador in forming the community. The DMX controlled RGB LEDs on the wristband

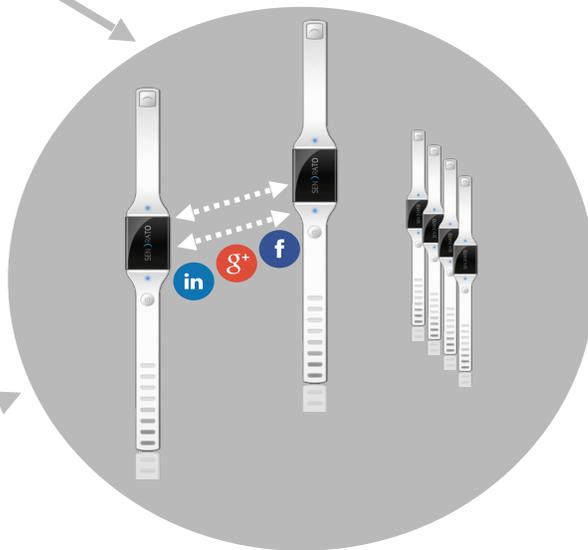


enable the visitors to literally merge with the light show. Since all the wristbands are time synchronised this results in an amazing spectacle in which the visitors contribute even more to the energy that is so important in creating a vibrant experience. Leveraged by the DMX protocol, the LJ's can control the wristbands and integrate them in the rest of the light show.

The button that is available for the visitor to interact with the wristband can be employed in various ways. The station approach "check-in support used to Whenever button of



main advantage of having this button compared to the check-in that is needed for RFID-based solutions is having your "facility" right at your wrist. The button can be used to different social and brand activations activities. It can be implemented a Facebook Like kind of operation. a visitor is watching a performance and pushes the his/her wristband this can result in an automatically



generated

Facebook comment being post on behalf of the visitor. The comment can refer to the performance the visitor is currently watching, which can be derived from time-space information that is present in the message generated by the button press. More interesting features can be derived from this button press capability. As can be analysed from social media posts from especially EDM events, questions related to what kind of track is currently playing and/or what is the original artist, are quite abundant. In combination with music recognition software and the fact the user and the e-mail address data, of a specific wristband is known, the button press can accommodate to immediately (within a minute) answer the visitor's pressing question.

Exploiting the capability of wristband-to-wristband communication can lead to even more elaborate social interaction scenario's. Again, enabled by a semi-simultaneous button press of two wristbands, they can be put in a local communication mode. In this local communication mode the wristband exchange their unique id's. Success of this exchange will be notified to both visitors by means of the LEDs lighting up in a certain color. After the exchange of the wristband id's a message is send to the base stations that contains the two id's and a timestamp to indicate the exact time at which the pairing of the wristbands took place. The message that is



received by the base station will be pushed up to the server that can generate a e-mail message containing for example the Facebook URL for the person that you have just connected to.

The ability to really interact via the wristband will strengthen the festival community by facilitating an ubiquitous means of communication with and between the visitors. Strengthening the festival community by knowing what your fans like and dislike.

### *Access Control, Cashless Payments and Brand Activations*

Since the Sendrato wristband includes an RFID/NFC tag it can be used as any other RFID-only wristband with exactly the same advantages. In this white paper we will only briefly discuss this RFID-based functionality. The passive RFID tag can run independent from the battery powered MCU.

Therefore, in case of a drained or failing battery, the RFID functionality will still be available. This includes key processes like access control and cashless payments. For access control we can integrate with several providers, including Intellitix, Glownet and Playpass. Our RFID tags are fully compliant with their specifications. Even in the case that an access provider is chosen that uses a non-standard RFID tag we are still able to assemble this onto our wristband module. For cashless payments we also support the same suppliers mentioned for access control. Unlike access control where the RFID is only read, (offline) cashless requires writing back information to the RFID tag. Integrating access control and cashless transactions into the Sendrato Festival Hub complements the visitor profiling process. Besides access control and cashless payments, the RFID tag can be used to implement “fun customer engagement” functionality. This functionality can be exploited for so called brand activations. Anything that can be build using the ability to uniquely identify a visitor in combination with (pre-)registered information can be used to interest sponsors in interacting with the visitors. We are not talking about check-in stations, since we have already argued that those are not needed anymore. We have implemented for example a photo booth application and free-drink access station. Our button press messages can be leveraged as well to explore new kinds of brand activations. Anything that can be associated with time/space/person can be implemented. A track that is currently played can be “liked” and at the same time a download-link can be send to the visitor for listening to this track and/or buying it from an online music store. A voting mechanism could be realised as well using the button press, maybe giving instant feedback to the visitors via large LED screens. However, we are sure that we cannot even start to think about all the possibilities. For this reason we are challenging you, as a festival organiser, to come up with new ideas while provide you with a working solution.



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